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Vegetation and terrain relationships in south-central New Mexico and western Texas.

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Relationships between landforms and plant communities for a 650,000 hectare area in the Chihuahuan Desert; New Mexico and Texas, were studied using aerial photography and field observations. Techniques used showed that plant communities were associated with definite landform units, and with the soil depth, texture, and moisture characteristics in the various units. Four major landform-soil units were identified on which a specific plant community was found, accounting for more than 30 percent of the community's distribution.

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SUMMARY

This study shows that the 1:50,000 scale aerial photography was an effective tool for identifying and mapping the distribution of landform conditions and plant communities on a regional basis. Although general soil and vegetation conditions were interpreted from the photography, the details concerning soil texture and soil depth on the landform units and the species composition of the plant communities were determined in the field.

Terrain analysis in the Fort Bliss study area identified four major landform categories: mountains/hills, alluvial fans, basin areas, and washes. These categories were divided into 14 smaller units using specific geomorphological characteristics, i.e. changes in relief, breaks in slope, differences in three-dimensional shape, drainage characteristics, erosion patterns, topographic position, and photo tones and textures. The landform units were described and their spatial distribution was mapped using photographic interpretation and analysis procedures. Field and laboratory studies verified these landform units as discrete landform units by evaluating rock type, soil profiles, and soil analysis. Soil texture and soil depth vary considerably among the landform units, with soil texture ranging from almost pure clay to pure sand and soil depth varying from zero to more than 2 meters. Soil water-holding capacity was inversely correlated with the percent sand and directly correlated with the percent silt and clay.

Land cover mapping on the aerial photography identified and delineated discrete photo patterns that were inferentially discrete plant communities. Continuity in mapping the photo patterns throughout the study area was essential because the photo pattern map formed the basis for collecting phytosociological and terrain data.

Because the identification of plant species was not possible on the aerial photography, species identification and species composition of the mapping units were determined in the field. A selected number of sample sites, at which terrain and phytosociological data were collected, were located among the photo patterns. The phytosociological data characterizing the plant community associated with each photo pattern was analyzed using computer techniques and the Tabular Comparison Method. From this analysis, 22 discrete plant communities were identified and described. From these data and the numerous random observations made enroute to the sample sites, associations between the plant communities and photo patterns were made. Most of the plant communities were found associated with a particular photo pattern. Several plant communities were encountered that had sufficiently similar photo patterns and could not be differentiated from each other on the 1:50,000 scale photography. These plant communities were separated using ground truth information.

The associations between the plant communities and landform units were determined in part from field data collected at each sample site. Detailed data describing the plant community and landform associations were collected in the laboratory by sampling the plant community overlay "sandwiched" with the landform overlay. The data substantiated the field observations and data, that certain plant communities were found more frequently on some landform units and less frequently or not at all on other landform units.

The plant communities described for the study area were grouped into four classes defined by the landform type, soil texture, and soil depth conditions:

1. Shrub and shrub-grass communities of the basin areas on sandy loam, sandy clay loam, silty clay loam, loamy sand, and sand soils more than 2 meters deep, with some interdunal soils less than 30 cm to the petrocalcic horizon.

2. Shrub and grass-shrub communities of some upper alluvial fans and upland areas underlain by bedrock on clay, clay loam, loam, or gravelly loam soils less than 30 cm deep.

3. Shrub-grass and grass communities of the lower alluvial fans, depressions in the basins, and the washes that receive water from adjacent areas on clay loam, silty loam, clay, and sandy clay soils more than 30 cm deep.

4. Shrub and shrub–grass communities of intermediate and sand-covered alluvial fans, the mesa, dissected hills, and some upper alluvial fans on clay loam, clay, sandy clay, and clay loam textured soils 15 to 30 cm deep.

PREFACE

This study was conducted to identify specific pattern elements that can serve as practical plant indicators of geological, biological, and cultural identities and properties within the study area and to document manual procedures for image analysis. The work reported on was done under DA Project 4A161102B52C, Task C, Work Unit 0010, "Indicators of Terrain Conditions."

The authors wish to express their appreciation to Mr. Kevin von Finger, Ecologist, and to Mr. James Conyers, Chief of Environmental Office, Directorate of Facilities Engineering, U.S. Army Air Defense Center and Ft. Bliss, Texas, for their cooperation and assistance in this study; to Mr. Cedric Key and Ms. Carla Ennis, Terrain Analysis Center (TAC), U.S. Army Engineer Topographic Laboratories (USAETL), for cartographic support, and to Mr. George E. M. Newbury III, Consultant's Office, and Ms. Claudia Newbury, TAC, for their field and laboratory assistance; and to Dr. Miklos Treiber and Mr. Ponder Henley, Center for Remote Sensing, Research Institute, ETL, for their technical assistance and perspectives in the data analysis effort.

The work was performed during 1978 and 1979 under the supervision of Dr. J. N. Rinker, Team Leader, Center for Remote Sensing; and Mr. M. Crowell, Jr., Director, Research Institute.

COL Daniel L. Lycan, CE was Commander and Director and Mr. Robert P. Macchia was Technical Director of the Engineer Topographic Laboratories during the study period.

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INTRODUCTION

The effects of vegetation on soil and of soil on vegetation have been studied and observed for many years. Early soil-vegetation studies in the western U.S. were made for purposes related to the growth of cultivated crops and grazing.[1,2,3] The present study was conducted in south-central New Mexico and western Texas where the vegetation was largely dominated by shrub species having various drought tolerances and occupying distinct soil conditions. The vegetation in the study area, although placed in the northern Chihuahuan Desert by Shreve, is thought by other plant geographers to be disturbance or disclimax communities, having developed from the true climax vegetation; Desert Grassland.[4,5]

The replacement of the climax grass communities by shrub-dominated communities has occurred over the past 100 years or more as a consequence of disturbance primarily related to grazing practices.[6] Although the climax grassland vegetation has been drastically changed, the shrub and grass species in the study area form discrete plant communities that are adjusted to the environmental conditions impinging upon them. Identifying the relationships between the plant species and the environmental factors enables the plant species or plant community to be used as an indicator of those environmental factors.

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[1] T.H. Kearney, L.J. Briggs, H.L. Shantz, W.J.W. McLane, and R.L. Piemeisel. "Indicator significance of vegetation in Tooele Valley, Utah." *Journ. Agri. Res.* 1:365-417. 1914.

[2] A.W. Sampson, "Plant indicators concept and status." *Bot. Rev.* 5:155-206. 1939.

[3] D.H. Gates, L.A. Stoddart, and C.W. Cook, "Soil as a factor influencing plant distribution on salt deserts of Utah." *Ecological Monographs*, V. 26, 1956, pp 155-175.

[4] J.L. Gardner, "Vegetation of the Creosotebrush Area of the Rio Grande Valley in New Mexico." *Ecology* 21:379-402. 1951.

[5] Ibid.

[6] Ibid.

Plant species as indicator organisms have a record of varying degrees of success. Not until the mid-1890's were conscientious efforts and systematic work begun on using plant species and plant communities as indicators.[7] The indicator concept is founded on the premises that (1) a plant is the expression of the environmental factors that can affect it and (2) that the ability of a plant to endure these stress factors depends on the plant's genetic properties and physiological processes.

In using plants as indicators of soil conditions, it is essential to know whether the conditions the species requires is some particular element or condition found in the soil that is necessary for its viable growth or whether the species is present merely because it can tolerate the conditions. The ideal indicator species is one with a definable, yet rather narrow, range for the factor(s) being considered, and whose occurrence is dependent upon this factor. Species with broad tolerance ranges, or ecological amplitudes for an environmental factor, do not make good indicators because they can fill many different ecological niches, which lowers their indicator usefulness. However, when two or more of the species with broad ecological amplitude have overlapping distribution and occur in the same community, their mutual occurrence and tolerances can be used to predict the factor intensity that each can tolerate. For example, *Artemisia tridentata* is an indicator of low saline soil and occurs on a wide range of soil textural and soil depth conditions. *Sarcobatus vermiculatus* is a shrub species indicative of medium to highly saline soils and occurs on fine-textured soils, silts and clays, with available soil water. Both species occur widely within the cold desert region of the Great Basin. Where these species occur together, predictions of the edaphic conditions common to each, yet not necessarily exceeding the tolerance limits of either species, can be made. The soil conditions that might be predicted in this example are a nonsaline to slightly saline, fine-textured soil with ground water in the root zone. Knowing the tolerance range for the factor(s) affecting the distribution of associated species enables the species to "act" as factor sieves and to reduce the range of the factor(s) affecting either species, thereby providing an effective mechanism for predicting environmental conditions.

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[7] A.W. Sampson, "Plant Indicators Concept and Status." *Bot. Rev.* 5:155-206. 1939.

Gates found significant differences in the edaphic conditions between soils occupied by the various species under study.[8] No species was found restricted in its distribution by a narrow tolerance range for any specific soil factor, and the range of the soil factors overlapped for all species. Although the species he studied may be unreliable as indicators of specific soil characteristics, in some instances the species could be used for imposing limits and estimating averages expected for certain soil factors.

Previous work in the U.S. and Europe has shown that using vegetation as indicators should be directed toward the plant community level. The reasons are:

1. The ecotypic differentiation of plant species.

2. The role of secondary or associated species in narrowing the factor range.

3. Consistency in extrapolating the geobotanical data.[9,10]

The principal difficulty in geobotanical investigations in unfamiliar regions is that of identifying the species characteristics of certain plant communities that indicate the assemblage of environmental factors in which they occur. Geobotanical studies often require data from a large number of sampling points over a large area to describe accurately the species-factor relationship of interest. Processing phytosociological data has been done effectively using the Tabular Comparison Method.[11,12] This method enables the investigator to identify the critical plant species from which plant communities are defined as more or less discrete units.

[8]D.H. Gates, L.A. Stoddart, and C.W. Cook, "Soil as a factor influencing plant distribution on salt deserts of Utah." *Ecological Monographs*, V. 26, 1956, pp 155-175.

[9]A.W. Sampson, "Plant indicators concept and status." *Bot. Rev.* 5:155-206. 1939.

[10]I.N. Beidman, "The significance of coedificators in the indicator properties of plant communities." *in* A. G. Chikishev, (ed). *Plant Indicators of Soils, Rocks, and Subsurface Waters.* Consultants Bureau. New York. 1965.

[11]D. Mueller-Dombois and H. Ellenberg, *Aims and Methods of Vegetation Ecology.* New York: John Wiley and Sons, Inc., 1974, p 547.

[12]A.W. Kuchler, *Vegetation Mapping.* New York: Ronald Press Co, 1967.

A major problem of the method has been the tedious manual techniques for manipulating the phytosociological data. Leith and Moore automated the handling of phytosociological data in the Tabular Comparison Method using digital computer techniques.[13] When the automated method is used, phytosociological data collected in the field can be processed rapidly and accurately, groups of species from among the sample sites (releves) can be isolated, and data can be displayed in tables from which the investigator can identify the critical plant species and the plant communities. At the same time, bias in arranging the sample site data is reduced. However, personal bias is not removed because the investigator does the final "fine-tuning" of the community arrangements using an arbitrary sort routine. The final appearance of the clustered data depends upon the investigator's ability to identify the dominant and subdominant species. Even though the processing of phytosociological data has been eased by using computer techniques, the difficulties in recognizing the critical plant associations and mapping their distribution remain.

Several vegetation studies were done in the area that were based on reconnaissance of an area in which the major plant communities were identified and described.* In using the reconnaissance method to study the vegetation in an area, two biases can occur: (1) in deciding which communities are important, and (2) in determining which sample sites will represent the "type" plant community. In the referenced studies, although the more conspicuous plant communities were generally identified and described, the major communities that were not encountered during the reconnaissance, or only infrequently encountered, were either left out or given less than community status. Thus, a rapid identification method is needed to determine whether critical communties were missed during the reconnaissance. For most vegetation studies, it is impractical to traverse large areas to ensure that all important communities have been accounted for.

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*Two of the studies were done by C. W. Merriam and H. K. Gardner.

[13] H.Lieth, and G.W. Moore, "Computerized clustering of species in phytosociological tables and its utilization for field work" in *Spatial Patterns and Statistical Distributions* by G.P. Patil, E.C. Pielou, and W.E. Waters (eds). University Park, PA: The Pennsylvania State University Press. 1971. pp 403-422.

To ensure complete and accurate identification, aerial photography and aerial photographic analysis techniques can be used for regional assessment and the identification of areas with discrete photo tones and textures. The discrete areas can then be investigated during field studies of the associated vegetation and environmental conditions. When using aerial photography for vegetation studies, the premise is that segments of the aerial photography with similar tones and textures represent ground areas with similar vegetation and terrain conditions. Although using aerial photography in vegetation studies is not new, aerial photographic interpretation techniques combined with the Tabular Comparison Method to do phytosociological studies has not been widely used. This combination offers a method by which:

1. Discrete plant communities can be identified prior to field reconnaissance, thus facilitating the reconnaissance effort.

2. Field sample sites can be located for collecting phytosociological data for the important "type" plant communities prior to going into the field.

3. Phytosociological data can be readily and accurately processed, and plant communities can be identified and described.

4. The spatial distribution of the plant communities can be used as a base for future environmental work.

OBJECTIVES

Based on the potential for combining the Tabular Comparison Method and aerial photographic interpretation techniques, the objectives of this study were

1. To evaluate using manual aerial photographic analysis and interpretation techniques to identify and describe the relationships between vegetation, landform, and soil conditions.

2. To determine the compatibility of the Tabular Comparison Method with aerial photographic interpretation techniques for conducting regional phytosociological studies.

THE STUDY AREA

The study area is located in south-central New Mexico and western Texas, within geographic coordinates 105°45'W, 31°45'N; 106°30'W, 31°45'N; 105°45'W, 32°45'N; 106°30'W, 32°45'N (figure 1). The area is included in the Lower Sonoran Life Zone by Merriam.[14] Shreve places this area in the Chihuahuan Desert, but suggests this northern portion could be in the Desert-Grassland Transition area.[15] Gardner places the area in the Desert Plains Grassl , based on his review of logs and journals of early travelers and records from expeditions i dis region.[16] Prior to major cattle ranching in the late 19th century, the climax plant co munities forming the Desert Plains Grasslands were dominated by grasses. Today, these grassland communities have been replaced by several shrub species; primarily, *Prosopis glandulosa, Larrea tridentata, Flourensia cernua,* and *Artemisia filifolia.* which dominate much of the landscape in the Tularosa Basin and Hueco Bolson and the alluvial fans coming into these basins, although isolated areas of *Sporobolus* grassland can be found. Grassland communities dominated by *Bouteloua eriopoda, B. curtipendula,* and *B. gracilis* still form the vegetative cover on the Otero Mesa and Hueco Mountains, but encroachment of shrub species into these grasslands in readily evident. The displacement of the grassland communities by the shrub communities is believed to be the result of the overgrazing practices that began in the late 19th century.

The climate of the study area is characterized as a hot, dry desert with temperatures above 0° C for all months.[17] There is an abundance of sunshine, and a wide range between the day and night temperatures and relative humidity (26 percent day and 56 percent night). Although precipitation is variable throughout the year, it is rather uniform throughout the study area, ranging from 21.4 to 24.9 cm per year (table 1). About half of the average annual rainfall occurs during July through October. This period coincides with the major portion of the growing season for most grass and shrub species. Summer precipitation is primarily localized thunderstorms of high intensity, with most winter moisture coming as low-intensity rains or occasional snow. The mean annual temperatures range from 17.7° C at El Paso, Texas to 14.8° C at Jornada Experiment Range, New Mexico (table 1).

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[14] C.H. Merriam, "Life zones and crop zones of the United States." US Dept. Agr. *Biol. Surv. Bull.* 10:1898. p 79.

[15] J.L. Gardner, "Vegetation of the Creosotebrush Area of the Rio Grande Valley in New Mexico." *Ecology* 21:1951. pp 379-402.

[16] Ibid.

[17] G.T. Trewartha, *Elements of Physical Geography.* New York: McGraw Hill Book Co. Inc. 1957.

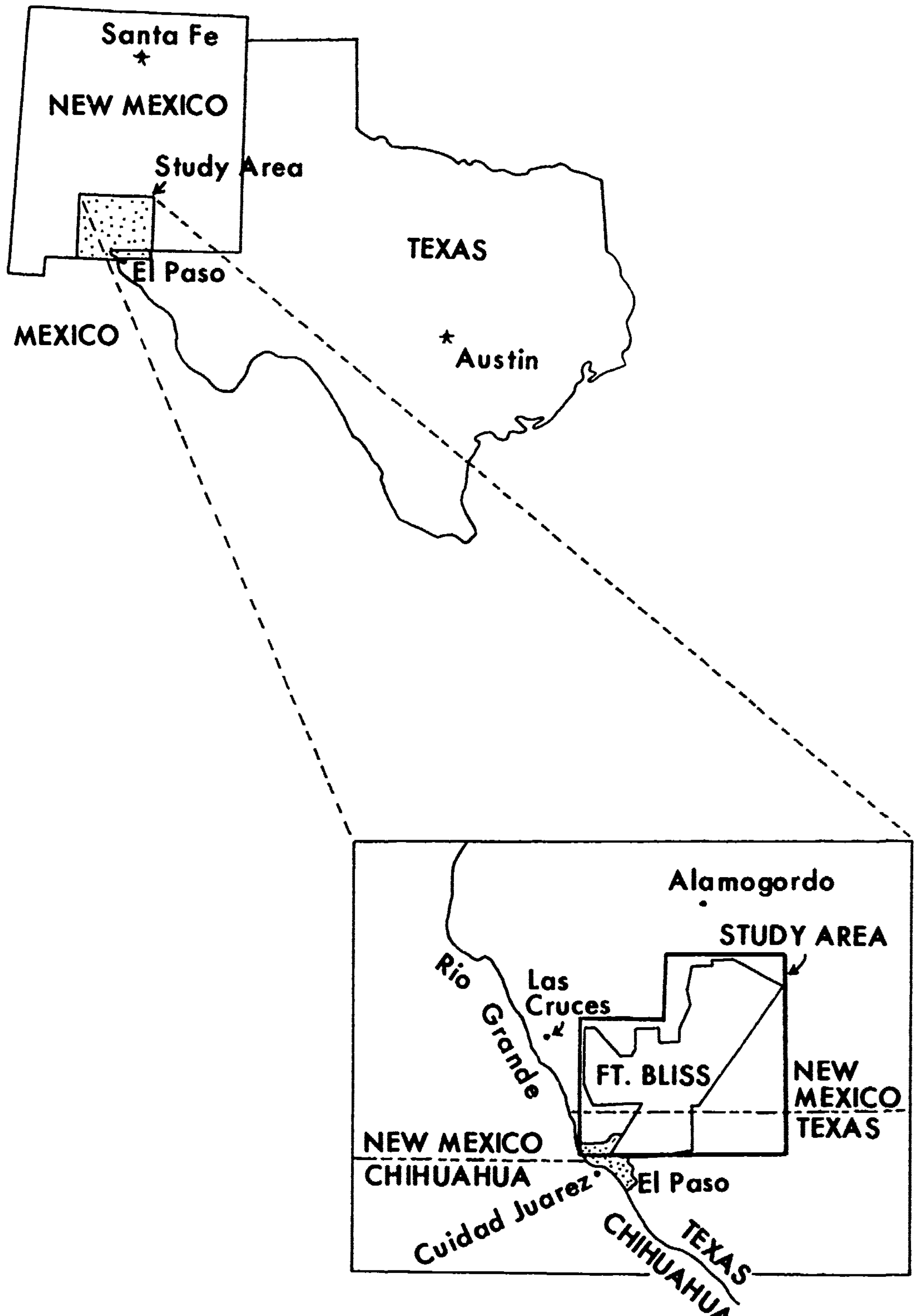


FIGURE 1. Location Map of the Study Area.

TABLE 1. **Mean Annual Temperature and Precipitation for Selected Stations**

Station	Temperature (°C)	(°F)	Precipitation (cm)	(inches)
El Paso, Texas	17.7	63.8	21.5	8.47
Alamogordo, New Mexico	16.2	61.1	24.9	9.8
Jornada Experiment Range, New Mexico	14.8	58.7	22.6	8.91
State University, New Mexico	15.6	60.1	21.4	8.41
Orogrande, New Mexico	17.1	62.7	22.9	9.01
White Sands National Monument, New Mexico	15.4	59.8	19.3	7.61

Total evaporation in the area ranges from 235 to 267 cm per year (92 to 105 inches). At State University, Las Cruces, New Mexico, total evaporation averaged approximately 235 cm per year from 1968 to 1977. Most of the potential annual evaporation, about 60 percent, occurs from April through September, during which time the mean monthly evaporation ranges from about 20 to 30 cm per month. Mean precipitation during this same period ranged from 0.5 to 4.3 cm per month (table 2), which was about 2 to 16 percent of the potential monthly evaporation. Annually, the mean potential evaporation is more than 10 times the mean annual precipitation.

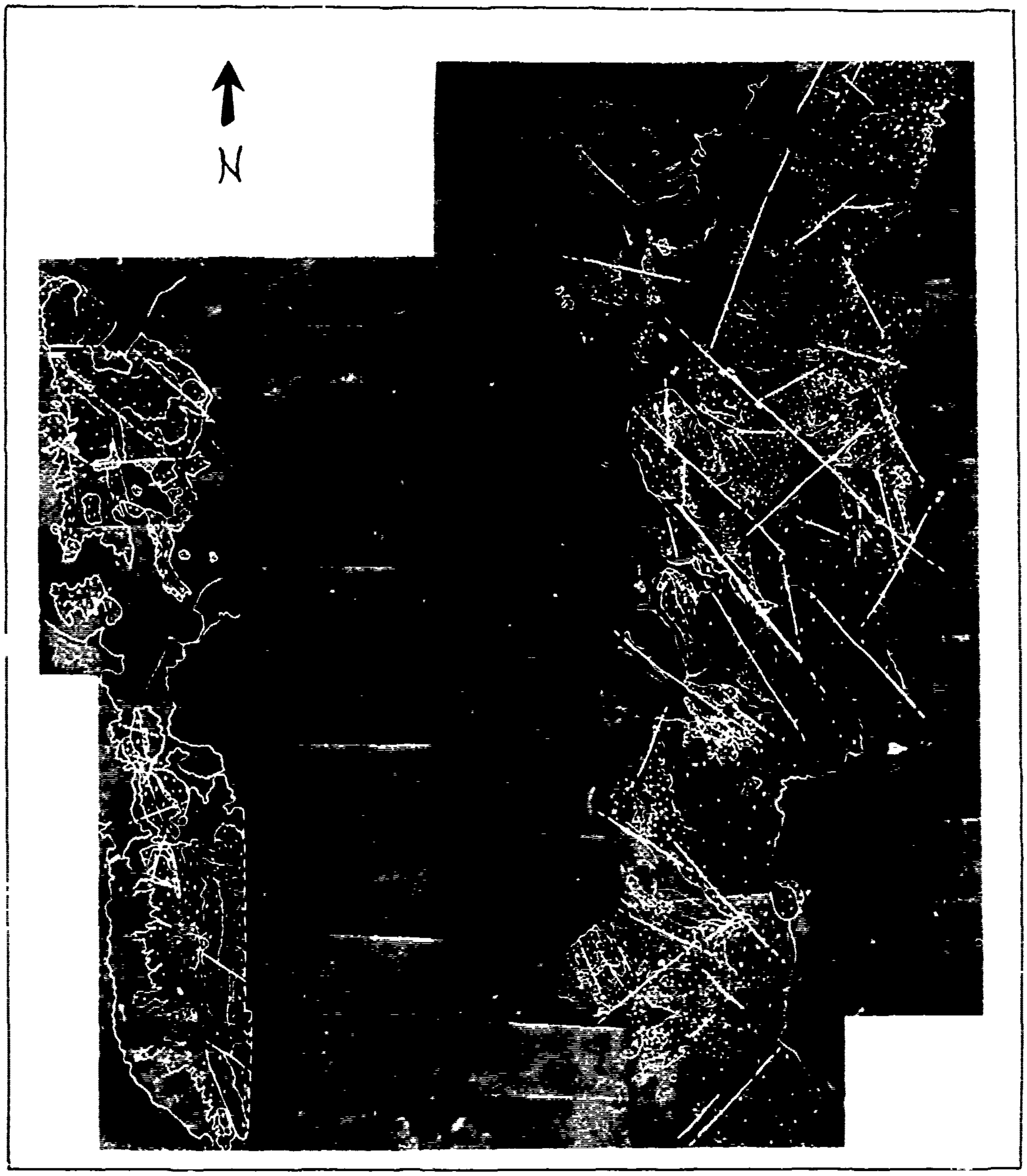
TABLE 2. Mean Monthly and Annual Total Evaporation and Precipitation, State University, New Mexico (1968–1977)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
	(Centimeters)												
Evaporation	8.1	11.4	19.3	25.4	30.2	30.5	29.2	26.7	20.3	16.0	10.2	7.9	235
Precipitation	0.9	1.1	8.1	0.5	0.8	1.3	4.2	4.3	3.2	1.8	1.2	1.2	28.6

Thornbury places the Ft. Bliss region within the Basin and Range physiographic province.[18] The area consists of approximately equal proportions of basin and mountain range and includes the Rio Grande Rift, a series of interconnected basins. The fault block mountains that trend north-south in the study area are the Franklin and Organ Mountains on the west and the Sacramento and Hueco Mountains on the east. The fault block mountains are separated in the south by the Hueco Bolson, parts of which have external drainage into the Rio Grande River, and in the north by the Tularosa Basin, which exhibits internal drainage.

The Franklin Mountains are composed of sedimentary and volcanic rocks (figure 2). The sedimentary rocks, mainly limestone with some sandstone and shale, are located on the northern and southern ends of the mountains. Andesitic volcanic rocks are located in the central portion of the Franklin Mountains. The andesite appears fault bounded. Granite underlies the Franklin Mountains and is visible along the eastern front. The Organ Mountains are formed of intrusive granitic rock with some sedimentary rocks on their southern flanks. Some volcanic rocks are found in the southwest part of the Organ Mountain range. The sedimentary rocks in both mountain ranges dip 30° to 50° west.

[18]William D. Thornbury, *Regional Geomorphology of the United States*, 2nd ed. New York: John Wiley and Sons, Inc., 1965.



Colluvial Material
Lower Alluvial Fans
Upper Alluvial Fans
Interbedded Sedimentary Rocks
Volcanic Rocks
Granite
Older Granite
Probable Fault
Material Boundary
Probable Material Boundary
Pattern Lost in Photo Overlap

Note: 1:550,000 Scale

FIGURE 2. Photo Geology of Fort Bliss and Adjacent Areas

The Hueco Mountains on the eastern side of the study area are faulted along the rock/basin boundary and along the Otero Mesa/Hueco Mountains boundary (figure 2). The rocks in the Hueco Mountains are primarily limestone with some shale. Several granitic intrusions, Cerro Alto and Red Hill, are present within the Hueco Mountains. The rocks forming the Otero Mesa are exclusively sedimentary. The mesa is capped with limestone, but sandstone and shale can occur in the escarpment. The rocks in this area dip a maximum of 30° to the east-southeast in the Hueco Mountains, and 10° to the east on the Otero Mesa. The regional dip is to the south or southeast.

The Jarilla Mountains, in the northeast part of the study area, are not related to either the eastern or western mountains (figure 2). These mountains are a granitic intrusion. Sedimentary rocks occur in the northern end of the mountains, and as isolated linear outcrops, partially ringing the main intrusive body of rock, indicating the intrusion is younger than the sedimentary rocks.

In figures 3 and 4, the structural and rock type relationships in the northern and southern portions of the study area are shown.

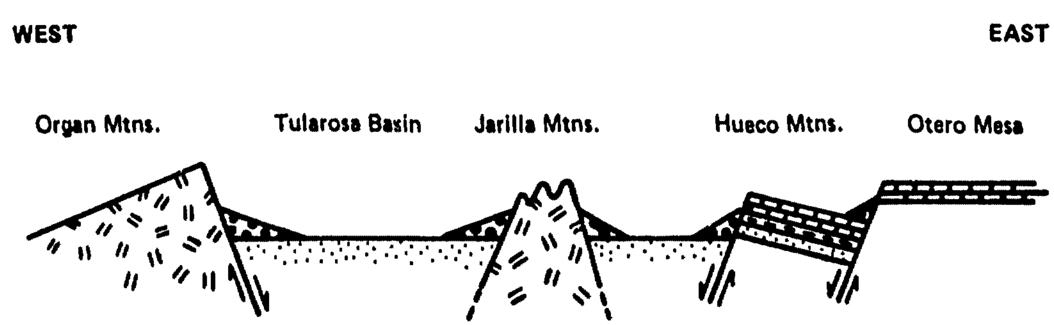


FIGURE 3. Generalized Geologic Cross Section Across the Southern Part of the Study Area.

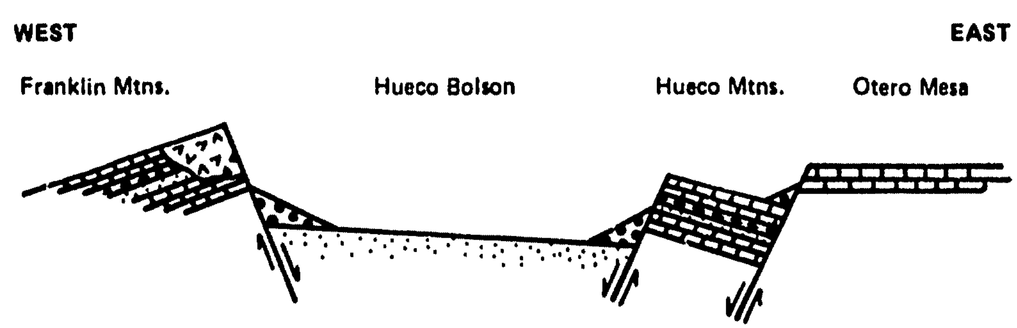


FIGURE 4. Generalized Geologic Cross Section Across the Northern Part of the Study Area.

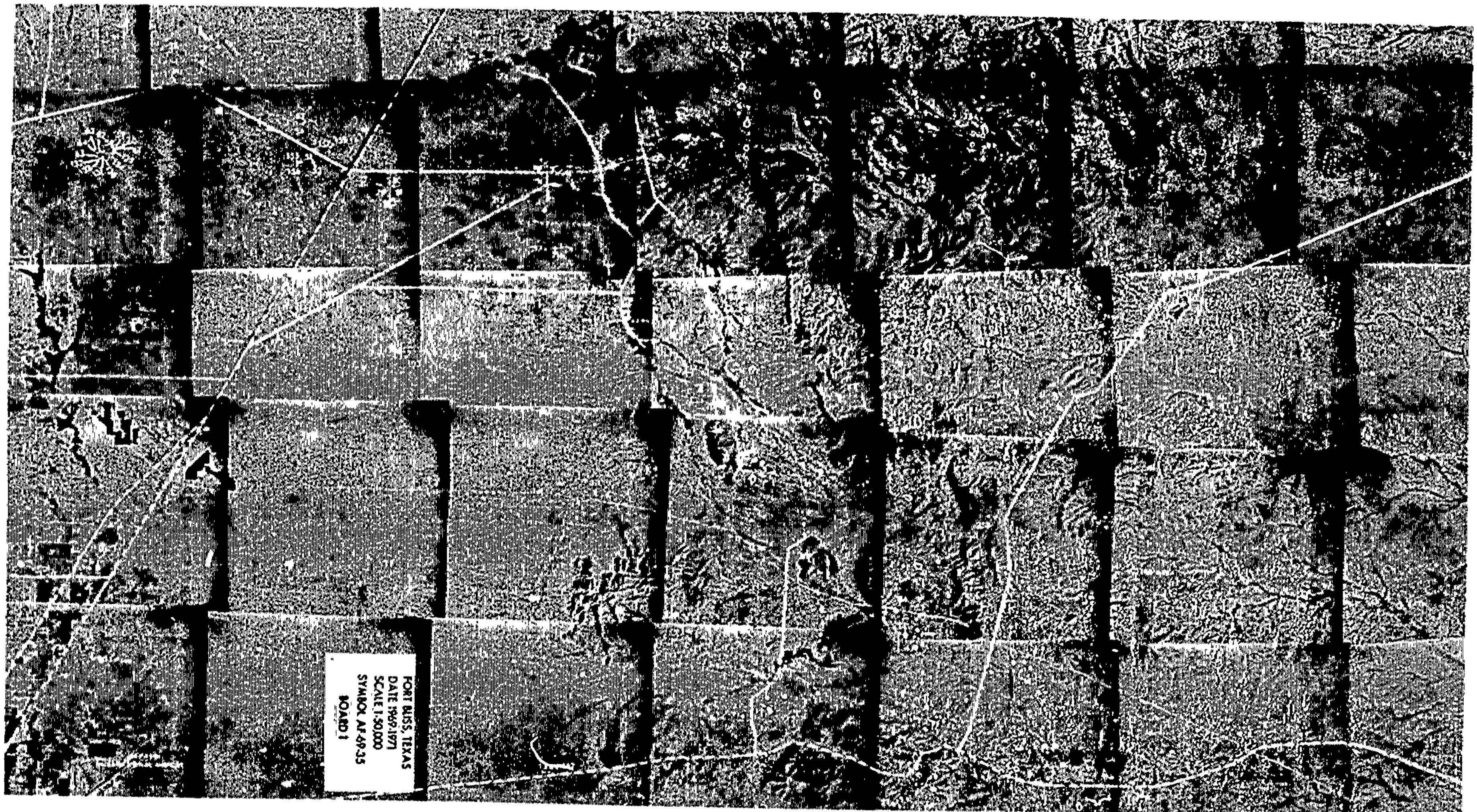
MATERIALS AND METHODS

The aerial photography used in this study was 22.9 by 22.9 cm (9 by 9 inches), 1:50,000 scale panchromatic stero aerial photography,[19] which was obtained from the Defense Mapping Agency, Washington, DC. Alternate photographs were assembled to form three 102- by 152-cm uncontrolled photomosaics, from which the photography could be viewed stereosocopically. Because of the size of the study areas, three photomosaics were needed to allow for some overlap between the mosaics. This imagery was used for identifying and describing the landform and vegetation conditions in the study area and for locating the sample sites. A geological photographic study was done using 1:100,000 scale panchromatic aerial photography, also obtained from the Defense Mapping Agency.[19]

The area was studied using standard porcedures of air photo analysis, i.e. a careful evaluation of the photo pattern elements of landform, drainage (plan and elevation), erosion, deposition, vegetation, cultural features, tones and textures, and special features. In the study, most information was obtained by evaluating landform; drainage-plan (pattern and density); drainage-elevation (gully cross sections and gradient); and the photo tones and textures on the 1:50,000 scale photography. The photo tones and textures were evaluated to identify discrete land cover areas on the photography and map their occurrence on each photomosaic. The landform and land cover units were then verified and described in detail from field data obtained at selected sample sites and from many random observations made enroute to these preselected sites. The sample sites were located, in part, with regard to the accessibility to the selected mapping unit. Site accessibility was important because some areas were physically inaccessible and others were "off-limits" because they were within the impact areas of the firing ranges. The field work was done in August and November 1977 and September 1978.

Phytosociological and terrain data were collected at 294 sample sites dispersed throughout the study area among the various land cover and landform mapping units (figures 5, 6, and 7). Each sample site can be located by the six-digit grid coordinates of the 1:50,000 scale topographic sheets covering the study area and by the photo number of the 1:50,000 scale aerial photography (appendix A). The field data and site descriptions were used in the

[19]The 1:50,000 scale photography is U. S. Air Force AF69-35, October 1969, and AF71-10, November 1971, and the 1:100,000 scale photography was obtained from Mark Hurd Aerial Surveys, 29 November 1974.

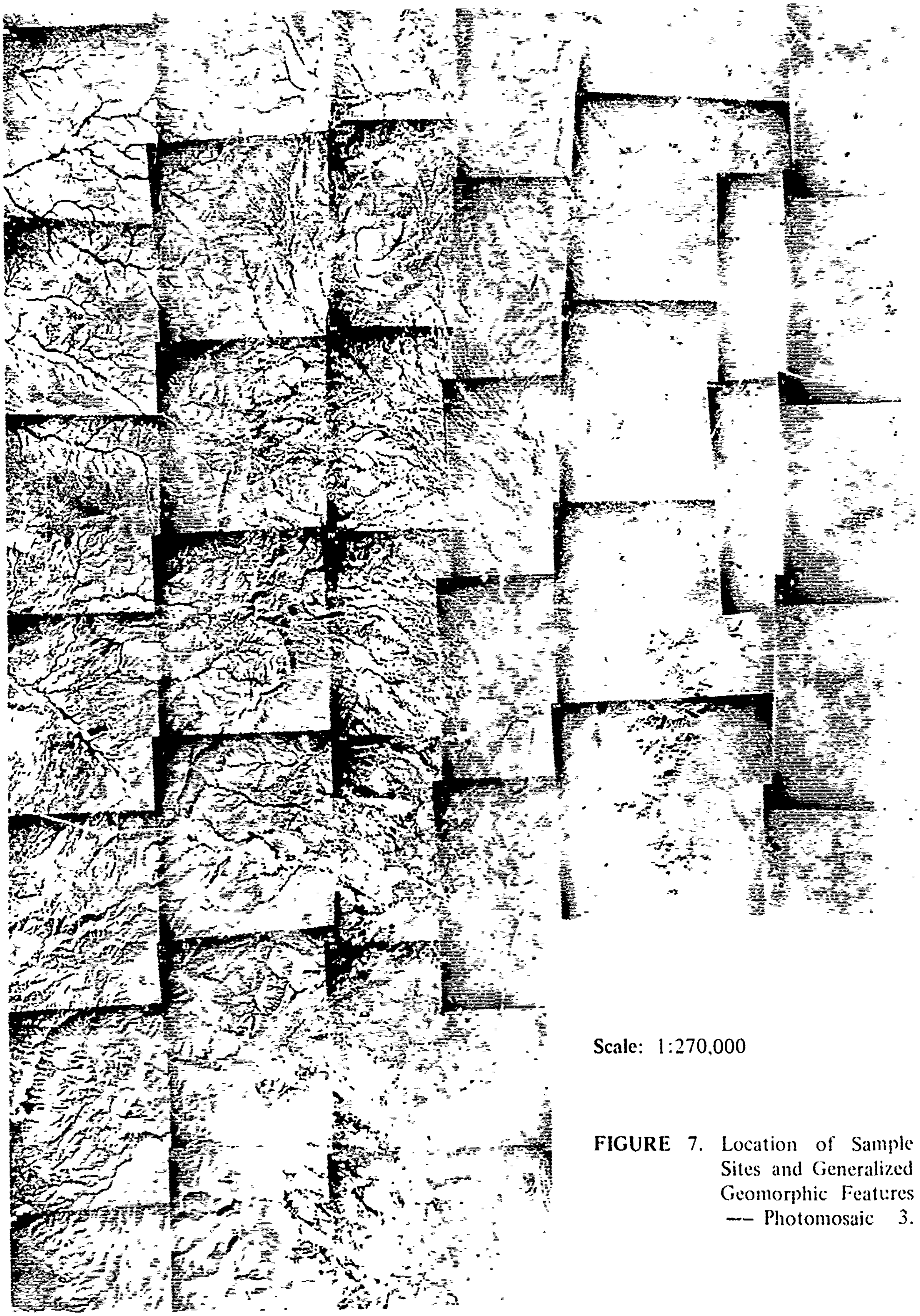


Scale: 1:270,000

FIGURE 5. Location of Sample Sites and Generalized Geomorphic Features — Photomosaic 1.

Scale: 1:270,000

FIGURE 6. Location of Sample Sites and Generalized Geomorphic Features — Photomosaic 2.



Scale: 1:270,000

FIGURE 7. Location of Sample Sites and Generalized Geomorphic Features — Photomosaic 3.

laboratory to refine the landform and land cover unit boundaries identified from the aerial photographic analysis. Soil conditions within the study area were described from soil samples collected from soil pits dug at 128 of the 294 sample sites. The depth of each soil pit was approximately 60 cm (24 inches), except where caliche pan (a petrocalcic horizon) or bedrock were encountered near the surface. Although most samples were taken from the surface horizon, 0 to 15 cm (0 to 6 inches), some samples were taken from deeper soil horizons that had textural or color differences. Samples were placed in plastic bags, labeled, sealed, and transported to the laboratory for analysis.

After air drying, each soil sample was passed through a 2.0-mm soil sieve and the percent of the total sample retained on the sieve was determined. A subsample of the material passing through the 2.0-mm sieve was oven dried at 105° C for 24 hours, then passed through several standard 20-cm (8-inch) sieves with openings of 2.0 mm, 1.0 mm, 0.5 mm, 0.25 mm, and pan. Sieved separates that were aggregates of smaller sized particles were broken by using a mortar and rubber-tipped pestle. Difficulties in breaking up aggregate particles of some samples passing the 0.25-mm sieve prevented further sieve separation. The percentages of sand, silt, and clay in the sample were determined from another subsample using the hydrometer technique.[20,21] The percentage of each fraction, >2.0 mm, 2.0 to 1.0 mm, 1.0 to 0.5 mm, 0.5 to 0.25 mm, 0.25 to 0.05 mm, 0.05 to 0.002 mm, and less than 0.002 mm, was determined for each sample on an oven-dry basis. Soil textural names were assigned to the soil samples according to U.S. Department of Agriculture nomenclature.[22] Samples containing 20 percent or more of gravel-sized particles in the whole sample were described as "gravelly," i.e. gravelly loam.

The soil samples were also analyzed for pH and total soluble salts (salinity). A subsample of the air-dried soil samples passing through the sieve with 2.0 mm openings was used for determining pH (1:1 ratio of soil sample to water mixture) using a Beckman Instruments pH Meter, Model N, and electrical conductivity (1:2 ratio of soil sample to water

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[20] C.A. Black, (ed). *Methods of Soil Analysis*, Part 1, Physical and Mineralogical Properties including Statistics of Measurement and Sampling. Agronomy series No. 9. Amer.Soc.Agron., Inc., Madison, Wisconsin. 1965.

[21] G.W. Cox, *Laboratory Manual of General Ecology*. Dubuque, Iowa: William C. Brown Publishers, 1967.

[22] Soil Survey Staff, *Soil Survey Manual*. US Department of Agriculture Handbook 18. 1951.

mixture) using a Lab Line Lectro MHO-Meter, Model MC-1, Mark IV. Soil salinity was calculated from the electrical conductivity measurement by using the following equation:

$$\text{Salinity (ppm)} = \text{E.C. umhos} \times 10^6 \text{ (at } 25^\circ \text{ C)} \times 0.64 \qquad (1)$$

where 0.64 is a conversion constant.[23]

Soil moisture retained in the soil at the 0.33 and 15 bar potentials was determined using the pressure membrane technique. The percent water held in the soil at the 0.33 bar and 15 bar potentials are those percentages approximating the percent soil water held at the field capacity (FC) and the wilting point (WP) conditions of the soil, respectively.[24]

The FC and WP values described the upper and lower limits of water held in the soil for plant uptake. The water content of the soil at FC is that retained in a soil against gravitational forces two or three days after the soil has been saturated and after free drainage has practically ceased. The WP is the accepted soil moisture content at which plants have difficulty or stop withdrawing water from the soil and become permanently wilted. The FC and WP soil moisture contents are expressed as a percent of the oven dry weight of the soil sample, and provide a quantitative measure of the water-holding characteristics of a soil at these pressure potentials. The difference between the FC and WP values is the plant available water capacity of the soil, PAW. The plant available water of the soil is an approximation, usually expressed as a percent of the oven dry weight of the soil, of the potential water that a soil could hold and that could be taken up by an actively growing plant.

Stepwise linear regression analysis was performed on the soil textural and soil moisture data to describe the relationships between (a) the percent sand (b) the percent clay and (c) percent fines (silt plus clay) with the percent soil water retained at the 0.33 and 15 bar potentials.

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[23]L.A. Richards, (ed), *Diagnosis and Improvement of Saline and Alkalai Soils.* US Department of Agriculture, Washington, DC, Handbook 60. 1954.

[24]M.B. Satterwhite, *Evaluating Soil Moisture and Textural Relationships using Regression Analysis,* US Army Engineer Topographic Laboratories, Ft. Belvoir, VA, ETL-0226, June 1980.

The study of landform as a separate pattern element was necessary because of the stated objective of evaluating the relations between landform, soil type, and vegetation. The criteria for identifying and evaluating landform units on the 1:50,000 scale stereoscopically viewed aerial photography, in decreasing order of importance, were: the three-dimensional characteristics of shape, size, slope, spacing, arrangement, and orientation; the drainage-plan characteristics of pattern and density (spacing of drainageways); the drainage-elevation characteristics of gully cross section, gully gradient (uniformity and steepness), and degree of incision; and the amount of structural control exhibited in the drainageways. These characteristics were used for identifying the major landform categories of (A) mountains/hills, (B) alluvial fans,(C) basins, and (D) washes; and the subunits within these major categories. The pattern element of photo tone and texture helped isolate subunits within these major landform categories, excluding the washes. With respect to the mountains/hills landform unit, the pattern elements of ridge crest characteristics, degree of ruggedness, rock layering, rock dip, and rock type were also used to differentiate the subunits of this major category. The major categories and the subunits were identified on each photomosaic and delineated on a clear acetate overlay, using a marking pen. This acetate overlay became a permanent record of the landform units, and was used to describe the landform conditions with the study area.

The percentage of the total study area occupied by each landform unit was determined by sampling the landform overlay for each photomosaic. This entailed laying a grid template, which had been divided into 2 x 2 cm segments, over each overlay. The landform unit falling beneath the intersection of the grid lines was determined. Care was taken to ensure that the overlap areas between the three photomasaics were sampled only once. A total of 6,033 sample points were taken in the 2.4 square meter photomosaics of the study area.

Identifying the land cover mapping units was based on differences in photo tones and textures that were discernible on the 1:50,000 scale stereoscopically viewed aerial photography. These discrete areas were identified on the photomosaics and mapped on an acetate overlay for each mosaic, maintaining consistency in the land cover interpretation and mapping throughout the study area. The minimum practical mapping unit size was 5 hectares (12 acres). Discrete areas identified on the photography but not satisfying the minimum mapping unit size were included in the adjacent larger unit having the most similar photo tone and texture.

If the assumption that the land cover mapping units are representative of discrete plant communities is correct, it should be possible to recognize and describe these communities using phytosociological techniques. Evaluating the phytosociological data collected at a number of sample sites in each land cover unit type would substantiate the validity of this assumption because a direct land cover unit-plant community relationship would be depicted by a rather homogeneous species composition and species ground cover values among the sample sites in a land cover unit. By locating each sample site of a plant community on the aerial photomosaic and noting the photo pattern of the site, the association between photo pattern and plant community can be made. The evaluation of this relationship between photo tone/texture (pattern) and phytosociological data would satisfy the first objective of this study.

The species composition, species percent ground cover, and ancillary site data were collected at 294 sample sites within the study area. Some replicate sites were located in each land cover mapping unit type. These sites were dispersed throughout the study area so the species diversity within the land cover type could be ascertained from the phytosociological data. The positioning of each sample site in the field was done to obtain a representative sample of the plant community and conditions. Care was taken to avoid the disturbances associated with roads, water tanks, or other localized disturbance factors. Some land cover units occurring over sizable areas were generally disturbed. In these units, samples were taken at locations that were representative of the general nature of the land cover unit. The large size of the study area, 6.0×10^5 hectares (1.5 by 10^6 acres), made a statistical field sampling of the landform or land cover units an impractical task for this study effort, because of limited resources.

At each sample site, a 20-by 20-meter sample quadrant was positioned so that the plant species composition and species percent ground cover within the quadrant appeared representative of the plant community. Often two quadrants were close to each other in the same mapping unit.

The ground cover class was estimated for each species found within the quadrant. The species ground cover was the estimated sum of the vertical projections of the crowns for all individuals of a species in the quadrant. Each crown was assumed to have 100 percent canopy closure within the ground-crown intercept. The effects of crown porosity, leaf shape, or leaf orientation upon the percent ground cover were not considered. A visual percentage of bare ground was also made. The relative percent ground cover for each species and the bare ground were assigned to one of seven ground cover classes:

GROUND COVER CLASS	PERCENT COVER	GROUND COVER CLASS	PERCENT COVER
+	Rare	3	26 to 50%
R	Less than 1%	4	51 to 75%
1	1 to 5%	5	76 to 100%
2	6 to 25%		

Other than the perennial grass species, herbaceous plant species were not used to characterize land cover mapping units because of their short lifespan or low presence in the study area. Annual herbaceous plants occasionally formed a dense ground cover in some recently disturbed areas, but the cover lasted for only a short time. Perennial grass and woody plants provided a better basis for community description because of their constant presence and reoccurring nature. Although climatic variability can change plant vitality and ground cover values, the occurrence of perennial species in a community does not vary as greatly as the occurrence of the annual species.

The species composition and percent ground cover for the shrub and grass species for the eastern portion of the Fort Bliss reservation (MacGregor Range), as presented by Kenmatsu and Pigott,[25] were included in this analysis. These data are the phytosociological data presented for sites 119 through 129.

The nomenclature for plant species used is in accordance with Hitchcock[26] for the grass species and Correll and Johnson[27] and Vines[28] for all other vascular plants.

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[25]R.D. Kenmatsu and J.D. Pigott, *A Cultural Resources Inventory and Assessment of McGregor Guided Missile Range, Otero County, New Mexico*, Part III. Botanical and Geological Studies. Tex Archeological Survey Research Report No. 65:III, University of Texas, Austin, TX. 1977.

[26]A.A. Hitchcock, *Manual of the Grasses of the United States*, 2nd edition (revised by Agnes Chase), US Department of Agriculture Miscellaneous Publication No. 200. 1950.

[27]D.S. Correll and M.C. Johnston, *Manual of the Vascular Plants of Texas*. Texas Research Foundation, Renner, Texas, 1970. p 1881.

[28]R.A. Vines, *Trees, Shrubs and Woody Vines of the Southwest*, Austin, TX: University of Texas Press, 1960. p 1104.

The Tabular Comparison Method was used to arrange and group the phytosociological data and to assist in identifying the plant communities. This procedure is described by Mueller-Dombois and Ellenberg[29] and by Kuchler.[30] The phytosociological data was analyzed, in part, using the "Phyto 69" computer program developed by Leith and Moore.[31] The computer technique essentially performs the same operations that could be accomplished clerically with the Tabular Comparison Method, except that by using Lin's algorithm, the clustering or grouping of data process has been automated.[32]

The frequency boundary limits required in the automated clustering of the phytosociological data were 10 and 75 percent. These limits remove those plant species occurring with a frequency less than 10 percent or greater than 75 percent from the total sample for clustering of the sample data and the sample sites because the rare or ubiquitous plant species aid very little in the discrimination between the plant communities. By temporarily removing these species from the total sample (during the evaluation and clustering of phytosociological data), critical species characterizing discrete plant communities can be readily identified.

Descriptions of the plant communities were based on the species physiognomic character, species composition, and species percent ground cover. The following procedures were used to recognize the plant communities from the clustered phytosociological data and to assign botanical names to the plant communities:

1. Determine the species and the species ground cover class in the quadrants.

2. Assign each species to a physiognomic class: (a) tree, (b) shrub, (c) grass, or (d) other herbaceous plants, with the tree class given the largest significance value and the other herbaceous plant group the smallest.

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[29] D. Mueller-Dombois and H. Ellenberg, *Aims and Methods of Vegetation Ecology*. New York: John Wiley and Sons, Inc., 1975. p 547.

[30] A.W. Kuchler, *Vegetation Mapping*. New York: Ronald Press Co, 1967.

[31] H. Lieth and G.W. Moore, "Computerized Clustering of Species in Phytosociological Tables and its Utilization for Field Work." In *Spatial Patterns and Statistical Distributions* by G.P. Patil, E.C. Pielou, and W.E. Waters (eds). University Park, PA: The Pennsylvania State University Press, 1971. 403-422.

[32] Ibid.

3. Identify the physiognomic character of each quadrant by summing the ground cover class values for all species grouped in a physiognomic class. The physiognomic class with the largest ground cover for the quadrant defines the physiognomic character of the quadrant as forestland, shrubland, grassland, or other.

Forestland: tree species totaling more than 25 percent of the ground cover.

Shrubland: (1) shrub species totaling 6 to 25 percent or more of the ground cover, with grass species forming less than 25 percent ground cover and less than 1 percent tree ground cover; or (2) shrub species totaling 1 to 5 percent ground cover with grass species forming less than 6 percent ground cover, and trees absent.

Grassland: (1) grasses totaling more than 25 percent ground cover, with shrub species forming less than 6 percent ground cover and trees less than 1 percent cover; or (2) grasses totaling more than 51 percent ground cover, with shrub species forming less than 26 percent ground cover and trees less than 1 percent ground cover.

Other: (1) bare ground areas with more than 75 percent exposed ground surface and the total vegetative cover less than 25 percent with no species forming more than 1 percent ground cover; (2) urban and built-up areas and water bodies: those areas where man's activities have drastically altered or eliminated vegetation cover, i.e. military cantonments, civilian housing and business areas, built-up military facilities, and constructed firing positions for military weapons.

4. Arrange the species in the physiognomic group by the ground cover class from large to small.

5. Identify the species with the largest ground cover class in the quadrant. The species with the largest ground cover class formed the primary name for the land cover unit. The species having the second largest ground cover class value is listed second. If two species occurred with equal ground cover class values, the shrub with the lowest numbered mapping symbol is used as the primary name in the land cover unit name.

Specific relationships between plant communities and the photo tones and textures were identified by correlating the photo tones and textures and the species composition and ground cover values for the clustered quadrant data. Because of the association between the tones and textures, the plant communities could be mapped throughout the study area. Some plant communities may have been grouped with other mapping units because their photo tones and textures were not sufficiently discrete or because at a specific location the plant community did not satisfy the minimum mapping unit size of 5 hectares.

Twenty-seven land cover mapping units were identified, for which an average ground cover class and the absolute and relative frequency for each plant species was determined.

The following parameters were used:

Qt – the total number of quadrants examined for a given land cover unit.

Q – the number of quadrants in which a species was found in a given land cover mapping unit.

Sum Q – the sum of all quadrants for all species found in a given land cover mapping unit.

Absolute frequency (Q/Qt times 100 percent) – the percentage of the quadrants occupied by a given species as a percent of the total number of quadrants for a given land cover unit. The absolute frequency of a plant species in a particular plant community was described as rare, less than 20 percent; infrequent, 21 to 40 percent; less frequent, 41 to 60 percent; frequent, 61 to 80 percent; and common, more than 80 percent.

Relative frequency (Q/Sum Q times 100 percent) – the number of quadrants in which a species was found as a percentage of the total of the quadrants for all species found in a given land cover unit.

Species average ground cover class – a categorical ground cover class assigned to each species based upon the average species ground cover class values for all quadrants assigned to a given land cover unit.

The grid point sampling procedure discussed previously was used to determine the percentages of the various land cover mapping units in the study area. Coefficients of similarity were calculated between each of the plant communities using the relative frequencies of each species in a plant community. Coefficients of similarity represent the similarity between two plant communities based on their respective species composition and the relative frequency of each species. The coefficients of similarity were calculated by the following equation:

$$SC = 2W/(A+B) \tag{2}$$

where W equals the sum of the smallest relative frequency percentage for a species found in Community A and Community B, and where A and B equal the sum of the relative frequency percentages for all plant species found in Community A and Community B, respectively.

RESULTS

SOIL ANALYSIS. The importance of soil conditions to the distribution of plant communities and plant species cannot be overstated. Soil pH, salinity, texture, and soil-water characteristics are important factors that affect the growth and distribution of plant species. Each of these soil parameters was determined in the laboratory for 128 of the sample sites (appendix 2). Other data, describing soil depth, parent material, and the petrocalcic horizon, were collected in the field at each of the 294 sample sites.

Soil pH. Soil pH in the study area ranged from 7.4 to 8.7. Sands, loams, and clay soils all had pH values within this range. There was no apparent relationship between the soil pH value and the soil texture of the soil samples in this study.

Salinity. Soil salinity, determined on the saturated extract, ranged from 17 to 340 ppm (parts per million) total soluble salts, and showed a relationship with the soil texture. Soils containing greater than 70 percent sand had the lowest range of salinities, ranging from 17 to 180 ppm; loam soils ranged from 46 to 224 ppm; and soils containing greater than 30 percent clay had the highest range, 85 to 340 ppm. These salinities were not great enough to effect plant distribution because they were substantially less than the level (1280 ppm total soluble salts) that begins to effect plant growth.[33]

Particle Size Analysis. The soils in the study area were highly variable in their textural composition, ranging from almost 85 percent clay to 90 percent sand. Most soils, however, were either loamy, clayey, or sandy in texture. The textural classes of the 128 surficial soil samples were either: gravelly clay, clay, loam, sandy clay loam, loamy sand, gravelly loam, gravelly silt loam, silty clay, or sandy loam. The percent gravel in the 128 surface soil samples ranged from 0 to 38 percent; the percent sand from 0 to 90 percent. the percent silt from 40 to 48 percent; and the percent clay from 0 to 85 percent. Data describing the particle size distribution among the six particle size classes for each sample are presented in appendix B, together with the soil textural classification.

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[33] L.A. Richards (ed). *Diagnosis and Improvement of Saline and Alkalai Soils.* US Department of Agriculture, Washington, DC, Handbook 60, 1954.

Soils containing more than 60 percent sand did not contain more than 3 percent gravel. The sands, loamy sands, and sandy loams contained less than 3 percent gravel-sized particles, loosely cemented by carbonates, and were easily broken apart with a rubber-tipped pestle. Substantial amounts of gravel (> 20 percent) were often found in soils high in percent silt and clay. Soils containing more than 20 percent gravel were all of the loam, silt loam, and silty clay loam textured soils, and about half of the clay loam, sandy clay loam, clay, and silty clay textured soils. Generally, soils obtained from the deeper portions of the profile contained more gravel-sized particles than surface samples.

The soil textural data show an inverse relationship between the percent sand and clay. Samples with a high sand content had a low percentage of clay and samples with a high clay content contained a low percentage of sand (figure 8). The percent sand and percent clay were determined for the portion of the sample passing through the 2.0 mm sieve.

The percent of the four soil separates, gravel, sand, silt, and clay, for each soil sample is summarized by landform mapping unit in appendix C.

Soil Moisture Constants. The soil water retained by the 179 soil samples ranged from 2 to 37 percent for the 0.33 bar potential, and from 1 to 23 percent for the 15 bar potential.

The moisture retention characteristics of a soil are highly correlated with soil textural characteristics. Soils holding the least amount of water at the 0.33 or 15 bar potentials were those with a high percentage of sand. Plots of the percent soil moisture for 0.33 and 15 bar potentials against the percent sand in the soil samples show that the percent sand and the soil water are inversely related (figure 9). The correlation coefficients (multiple R values) for these relationships were 0.96 and 0.93, for the 0.33 and 15 bar potentials, respectively, which were determined by stepwise multiple regression analysis.[34]

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[34]J.Dixon, "BMD: Biomedial Computer Programs." Univ. of Cal F. pub in *Automatic Computation No. 2*, Univ. of California Press, Berkeley, 1971.

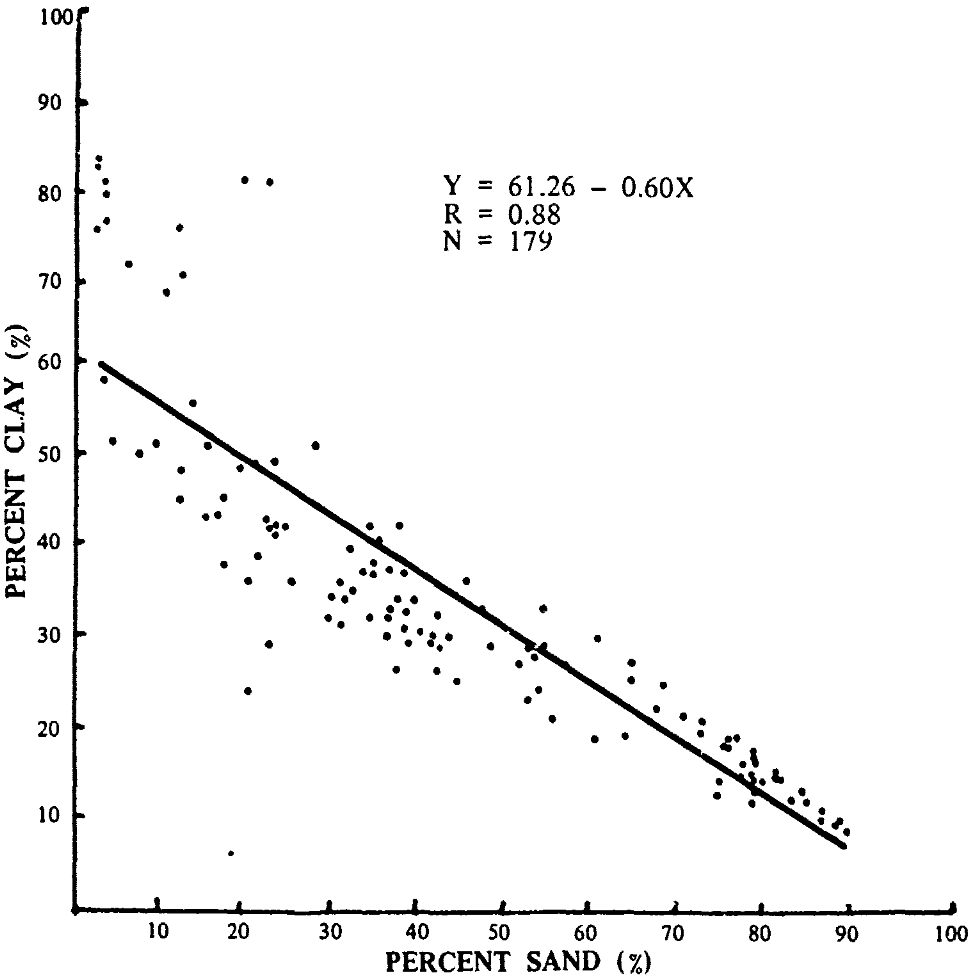
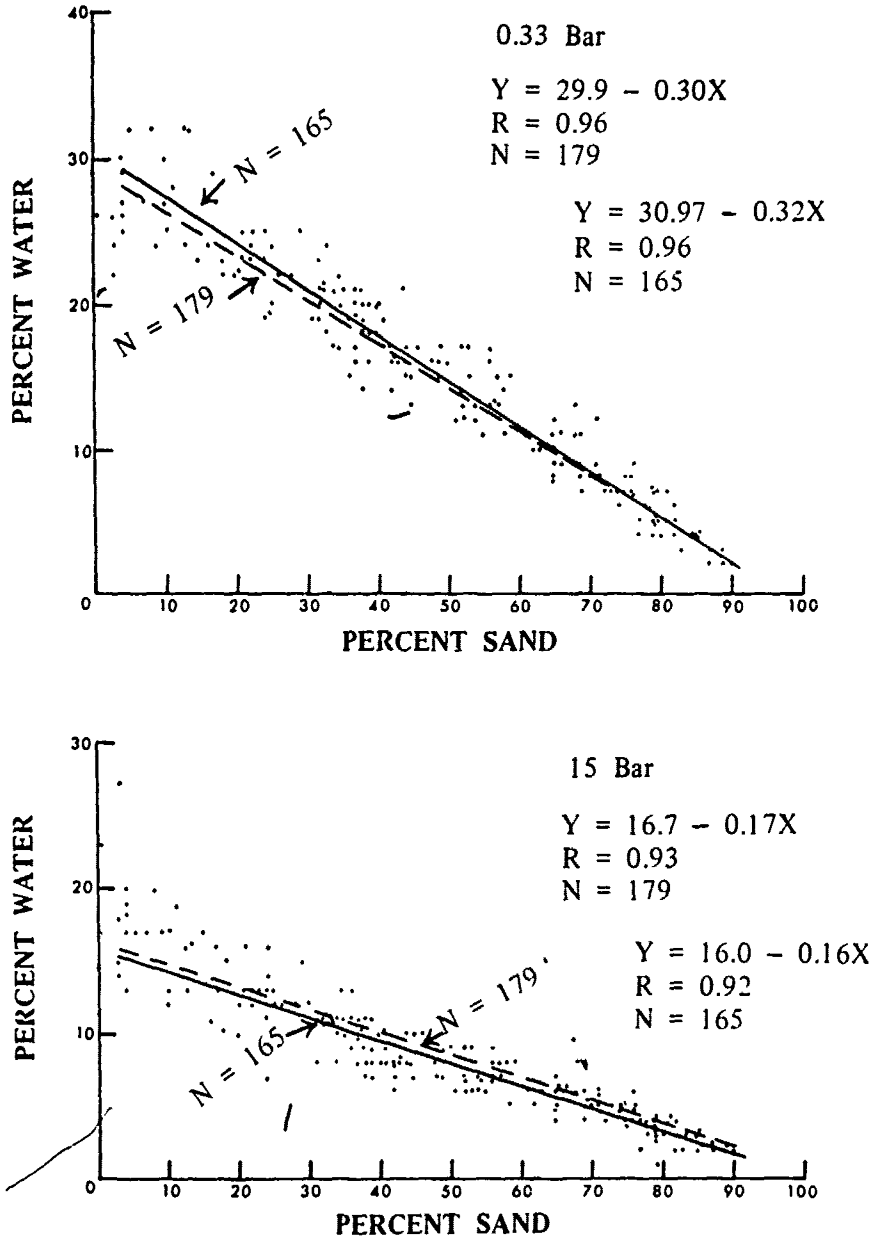


FIGURE 8. Distribution of Soil Samples by Percent Sand and Percent Clay.



Source: Satterwhite

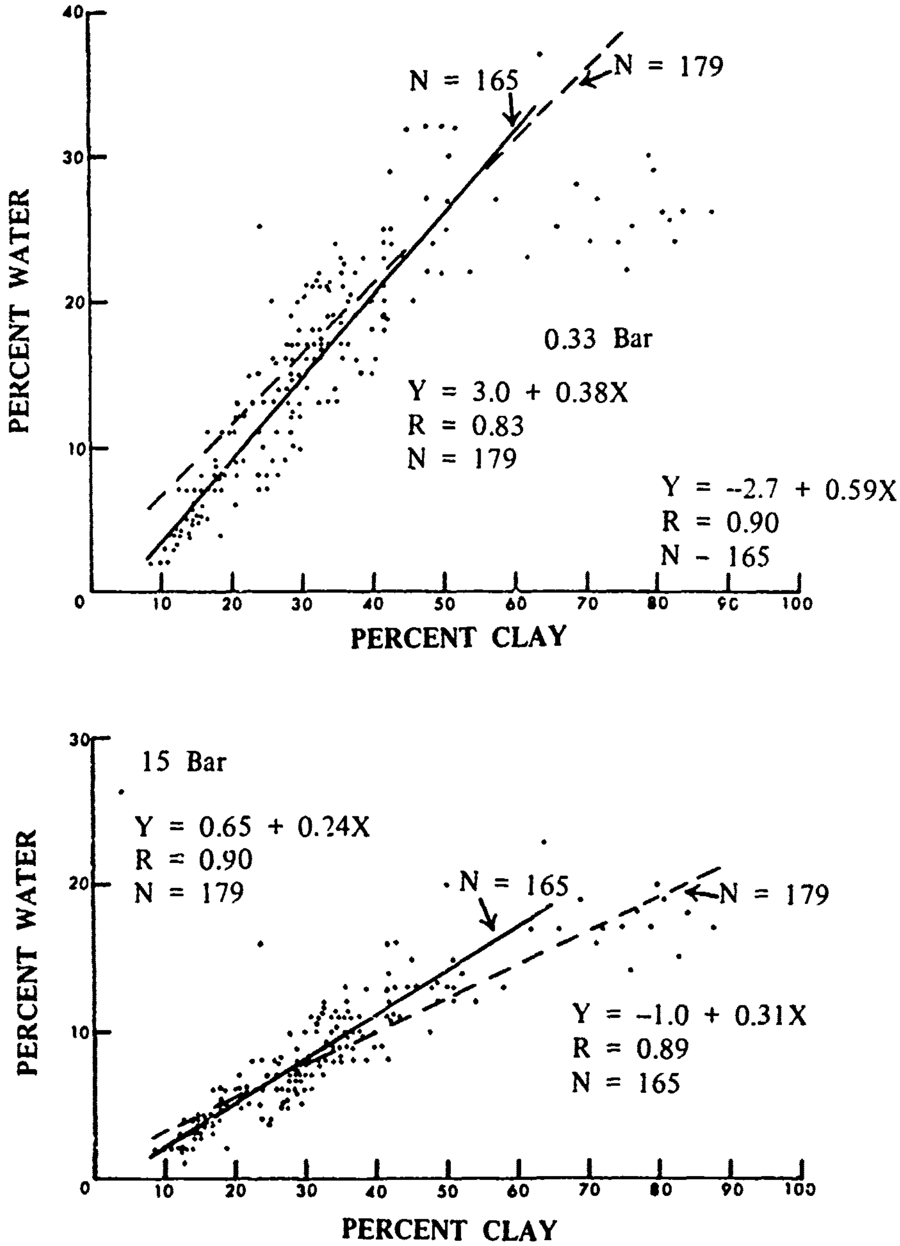
FIGURE 9. Percent Soil Water Held at the 0.33 and 15 Bar Potentials Plotted as a Function of Percent Sand.

The soil moisture for the 0.33 and 15 bar potentials were highly and directly correlated with the percent clay in the soil (figure 10). The correlation coefficients (multiple R values) for the relationships between the percent clay and the percent soil water held at the 0.33 and 15 bar potentials were 0.83 and 0.90, respectively. As the percent clay increased between the soil samples, a proportional increase in the soil water held at the 0.33 and 15 bar potentials was observed. This relationship was consistent for samples having less than 62 percent clay. Samples with more than 62 percent clay did not hold a proportionately higher amount of soil water at the 15 bar potential (figure 10.)

The 14 samples containing 62 percent or more clay were obtained from the soils developing on shale beds and alluvium on the interbedded limestones and shales and contained partially weathered shale fragments that ranged from medium sand to fine gravel in size.

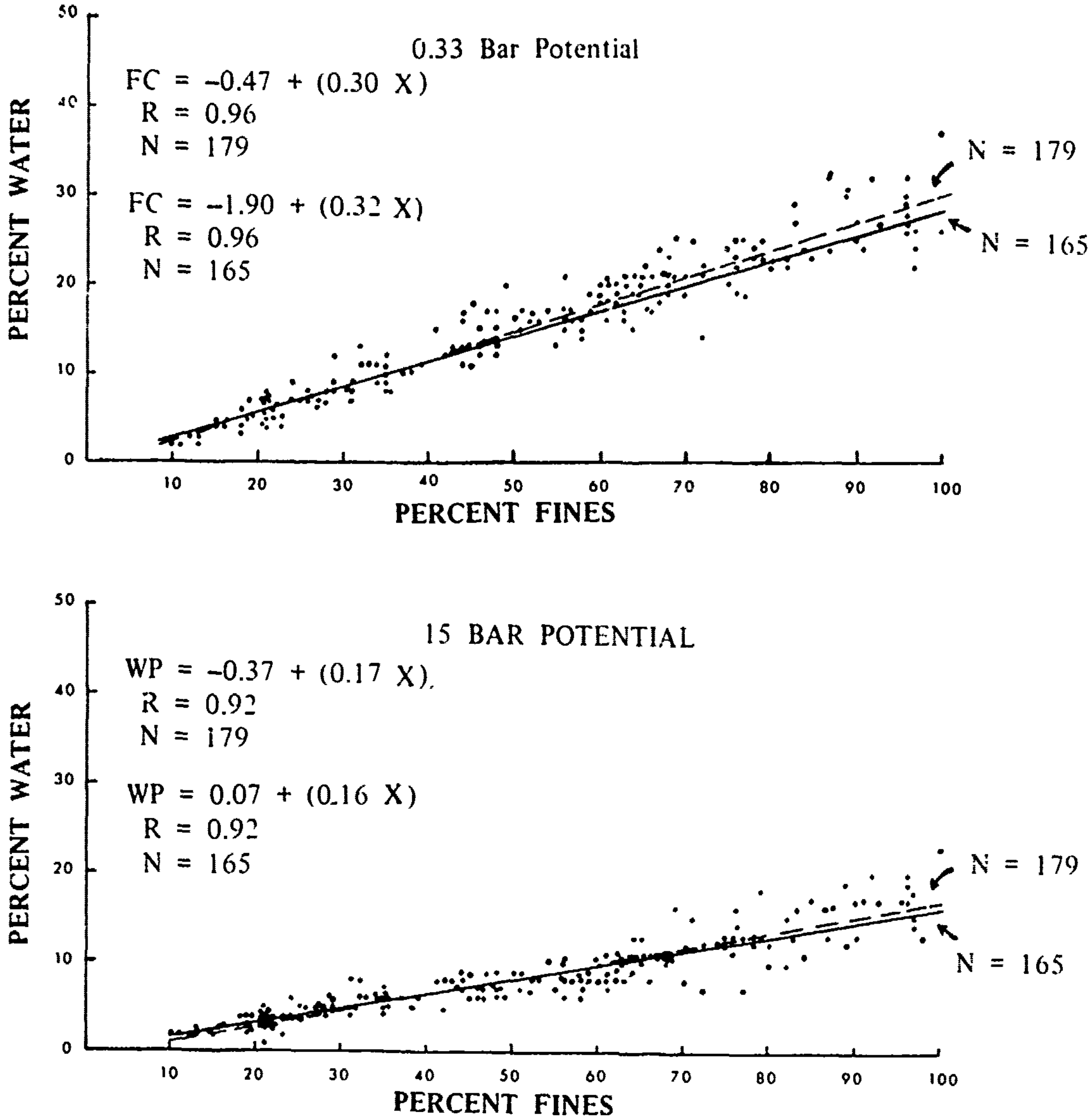
The amount of water held in these samples was similar to amounts determined for samples containing less clay. An explanation for this situation might be related to the differences in the soil pore space for samples of different textural composition. In sandy soils, the pore space is relatively large and the forces holding the available water are relatively weak. As the pressures are applied to a saturated soil, these large pores are readily emptied of water, with only a small amount of absorbed water on the soil particles. In clay soils, the pore sizes are smaller, more uniformly distributed, and tend to absorb greater amounts of water. At any gradually increasing soil water potential, these soils will gradually decrease in water content. The clay soils will retain more water at the higher potentials than will the sandy-textured soils at the same potential.

Soils holding the least amount of water at either the 0.33 or 15 bar potentials were those with a high percentage of sand. The soils holding the largest amount of water had a high percentage of clays or fines. The relationships for the sand, clay, and fines in the water retained at the 0.33 and 15 bar potentials are shown in figures 9, 10, and 11, respectively. The regression curves were generated from the stepwise regression analysis of soil texture and soil water data for 179 soil samples. Regression curves were also generated from data for 165 of the 179 soil samples that did not contain weathered shale particles.



Source: Satterwhite

FIGURE 10. Percent Soil Water Held at 0.33 and 15 Bar Potentials Plotted as a Function of Percent Clay.



Source: Satterwhite

FIGURE 11. Percent Soil Water Held at 0.33 and 15 Bar Potentials Plotted as a Function of Percent Fines (Silts and Clay).

Stepwise multiple regression analysis showed a strong and direct relationship between the percent soil water held at the 0.33 bar (FC) and the 15 bar (WP) potentials with the percent sand plus the percent clay in the soil samples. The regression equations expressing these relationships were

$$FC = 32.9 - (0.33 \times \text{percent sand}) + (0.05 \times \text{percent clay}) \quad (3)$$

$$WP = 11.2 - (0.12 \times \text{percent sand}) + (0.09 \times \text{percent clay}) \quad (4)$$

The correlation coefficients (multiple R values) were 0.96 and 0.93, respectively.

The percent water retained at the 0.33 and 15 bar potentials were also strongly and directly correlated with the percent fines (silt plus clay) in the soil sample (figure 7). Regression equations developed for these relationships were

$$FC = -0.42 + (0.30 \times \text{percent fines}) \quad (5)$$

$$WP = -0.32 + (0.17 \times \text{percent fines}) \quad (6)$$

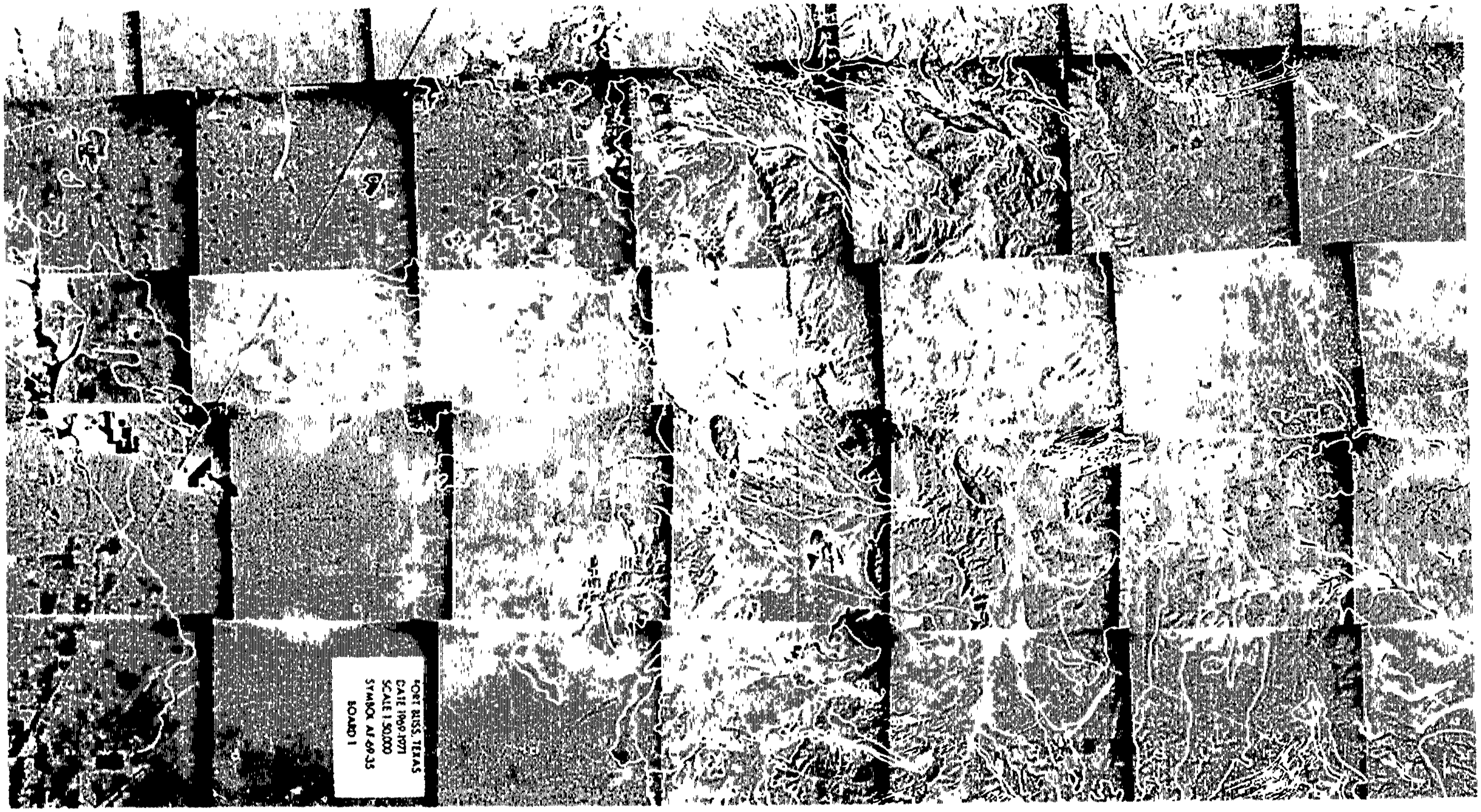
The correlation coefficients (multiple R values) were 0.96 and 0.92, respectively.[35]

[35] M.B. Satterwhite, *Evaluation Soil Moisture and Textural Relationships using Regression Analysis*, US Army Engineer Topographic Laboratories, Ft. Belvoir, VA, ETL-0226, June 1980.

LANDFORMS. Four major landform categories were identified in the study area from the stereoscopically viewed aerial photography. They are mountains/hills (A), alluvial fans (B), basin areas (C), and washes (D). The spatial arrangement of the major landform units and their subunits are shown in figures 12, 13, and 14. Each of the major landform categories, except the wash category, was further subdivided into discrete landform subunits. The relative percentage of the study area occupied by each landform subunit is presented in table 3, and the spatial relationships between the landform units are shown in figure 15.

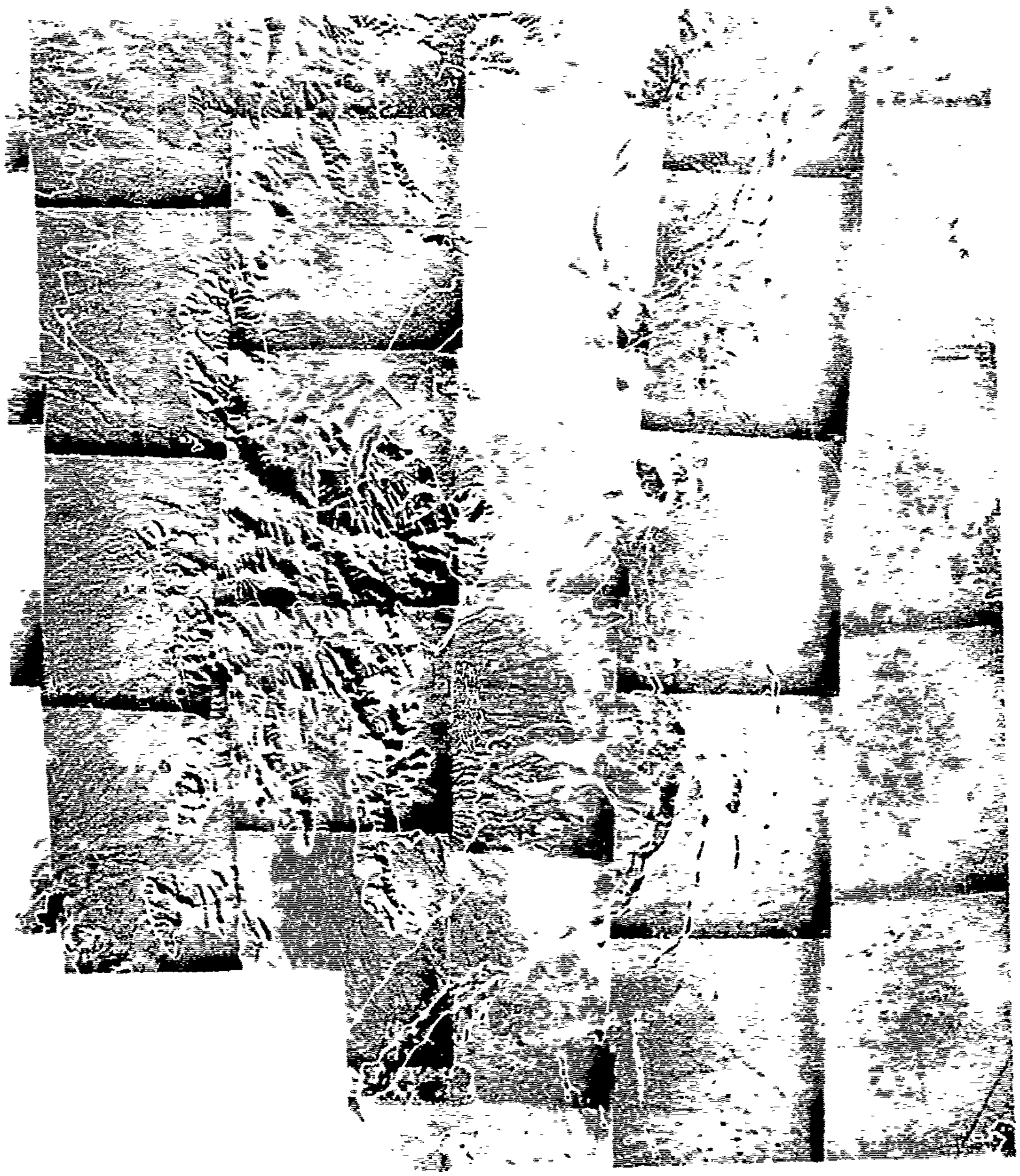
TABLE 3. Landform Units and Their Percentages in the Study Area

Major Landform Unit	Map Symbol	Landform Subunit	Percent of Study Area
Mountains/Hills	A1	Mesa	15.8
	A2	Highly dissected hills	16.1
	A3	Rugged, sharp-crested mountains	2.3
Alluvial Fans	B1	Primary high elevation fans	10.8
	B2	Secondary high elevation fans	1.2
	B3	Mottled, intermediate elevation fans	6.8
	B4	Dark-toned, lowest elevation fans	3.6
	B5	Fans covered with deep aeolian sand	3.5
	B6	High elevation anomolous fans	0.7
Basin Areas	C1	Light-toned, speckled sand dunes	30.2
	C2	Dark-toned, rough-textured dunes	2.6
	C3	Low, smooth areas	2.5
	C4	Small, dark-toned depressions	1.5
Washes	D	— — — — —	2.0
			99.6



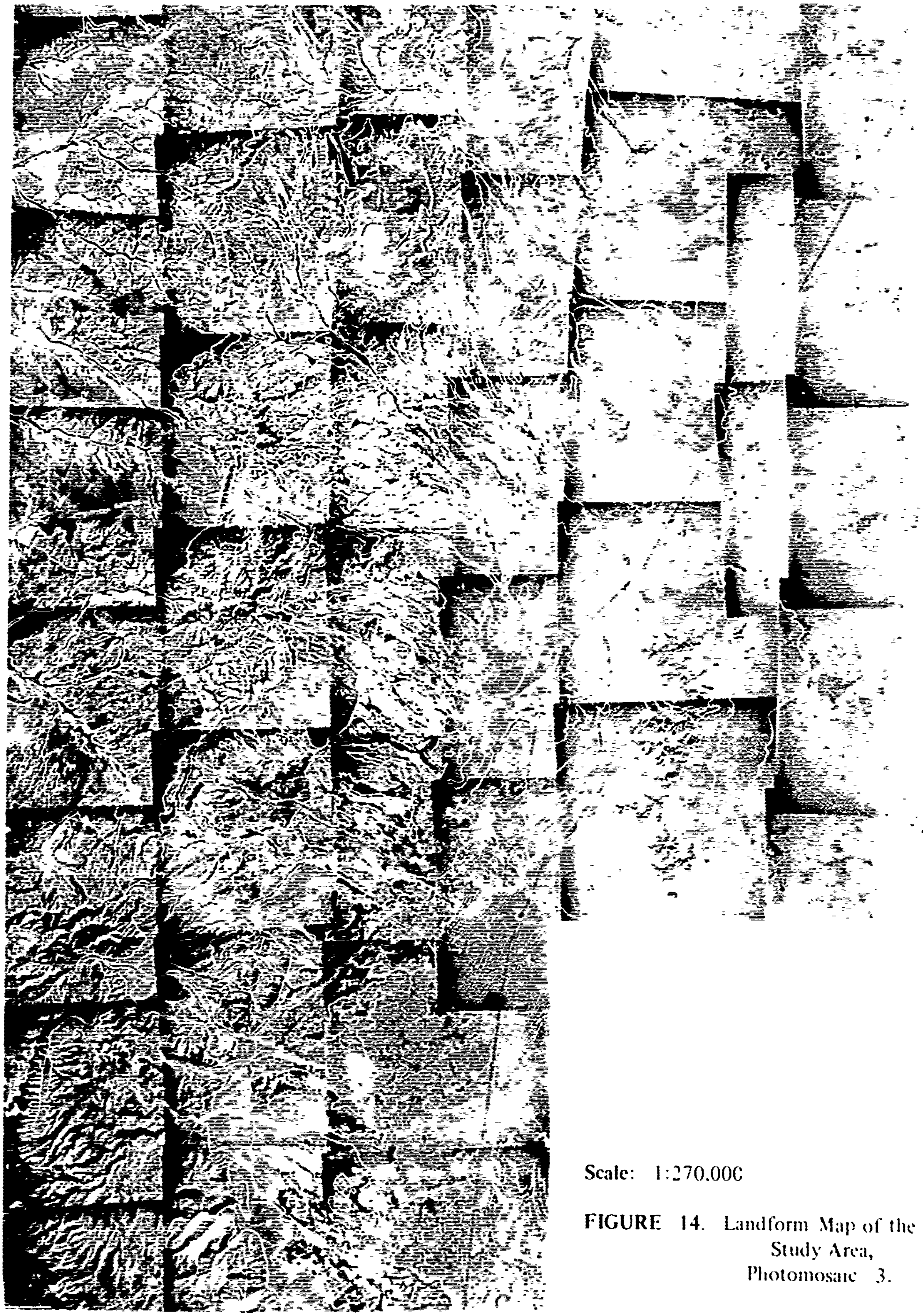
Scale: 1:270,000

FIGURE 12. Landform Map of the Study Area, Photomosaic 1.



Scale: 1:270,000

FIGURE 13. Landform Map of the Study Area, Photomosaic 2.



Scale: 1:270,000

FIGURE 14. Landform Map of the Study Area, Photomosaic 3.

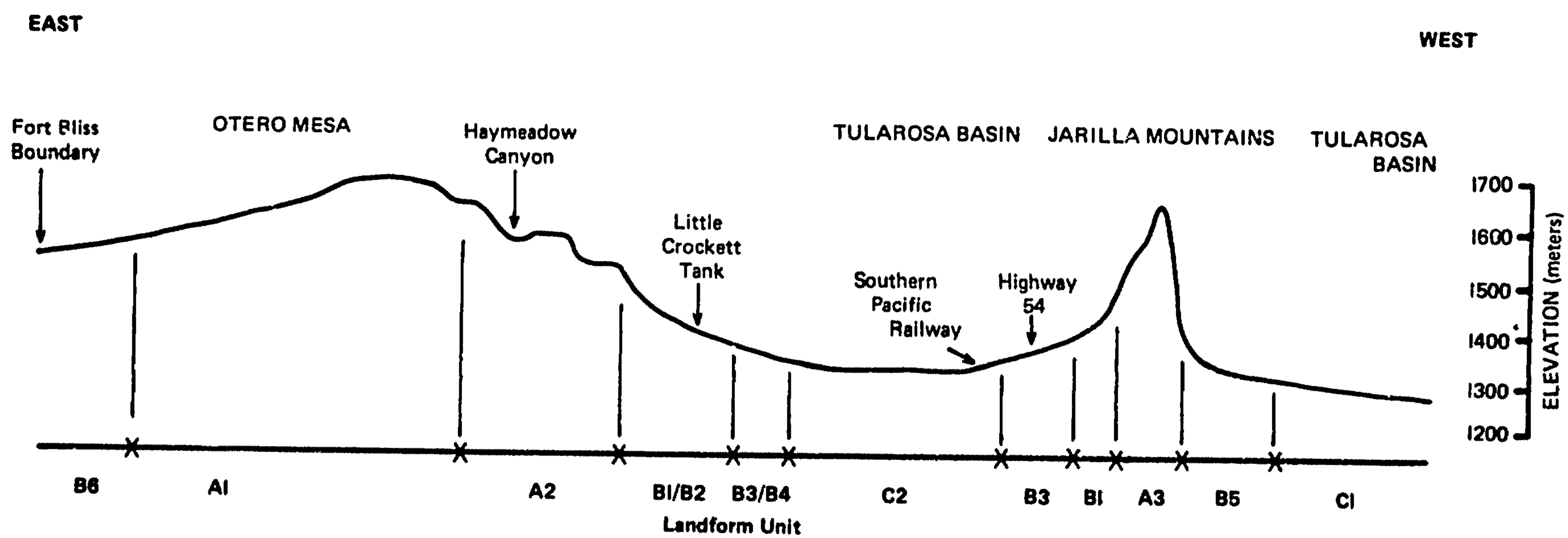


FIGURE 15. Schematic Cross Section of the Northern Part of the Study Area Showing the Relationships Between the Landform Units.

The mountains/hills areas comprise 34 percent of the study area. They are the highest in elevation, and the most rugged parts of the study area. Relief is generally high, and slopes are often steep (> 70 percent). The drainageways are usually strongly incised, and drainage patterns in these areas are dendritic. A high degree of structural control is exhibited locally, and the drainage density is generally high. Three subunits were identified in this landform category: (1) large, flat-topped mesas (A1); (2) large, highly dissected rock masses that include many relatively small, isolated rock bodies (inselbergs) (A2); (3) large areas of rugged, sharp-crested mountains, which also include some inselbergs (A3).

Alluvial fans comprise 27 percent of the study area. They are identified by their distinctive fan shape, distributary drainage pattern, moderate slope (3 to 5 percent), and topographic position between the rock masses and the low, flat basins (figure 15). Relief and drainage characteristics on the alluvial fans vary according to the topographic position and in the degree of fan development. Fans occur both individually and as broad aprons (bajadas). The alluvial fans were subdivided into six discrete subunits, B1 through B6 (table 3).

The basin areas occupy 37 percent of the study area and are the largest landform units. They are flat, with little relief, and occupy the lowest elevations. Few drainageways are apparent in these areas, although some channel-like depressions with gullies along their sides were identified. The gentle regional slope of the basin areas in the north is to the north, and in the south, is to the south; but the boundary between these two areas is very difficult to discern on the aerial photography. The basin category was divided into four discrete subunits, C1 through C4 (table 3).

Washes, comprising 2 percent of the study area, are the major stream channels upstream from where the drainage pattern becomes distributary or where the major channels enter the B4 alluvial fans. Washes include the immediate overflow areas associated with the channels. Distinct channels, defined by steep side walls, are sometimes observable on the alluvial fans, but drainageways in these areas were usually identified by the contrasting very dark and very light photo tones within them. Washes in the mountains/hills landform unit have either U– or V–shaped cross sections; whereas, those in the alluvial fan complex were box-shaped cross sections with almost vertical side walls and flat bottoms.

Mountains/Hills.

Mesa (A1). The mesa (A1) landform subunit, located in the eastern portion of the study area, is composed of relatively smooth, flat-topped high areas that slope gently to the east (figure 16). The mesas are bounded at least on one side by a steep escarpment (figure 17). The unit includes the western portion of the Otero Mesa and several large buttes similar to, but separate from, the Otero Mesa. The mesa landform occurs on the highest elevations and comprises nearly 16 percent of the study area. Drainage is sparse and generally dendritic, although some discontinuous drainage was observed. Drainageways are moderately incised and are usually shallow and U-shaped. The A1 landforms are underlain by gently dipping sedimentary rocks, which are predominantly limestone with some shale and minor sandstone.

Soils on the A1 landforms are primarily clay loams with gravel. Soil depth is more than 45 cm on areas with less than 3 percent slope, but on steeper slopes, the soil depth ranged from 15 to 30 cm. The amount of gravel in the surface soils ranged from 10 to 20 percent with the gravel particles less than 2.5 cm in diameter. In shallow drainageways, soils are silty loam and contained few pebbles. Exposed bedrock occurred in limited areas.

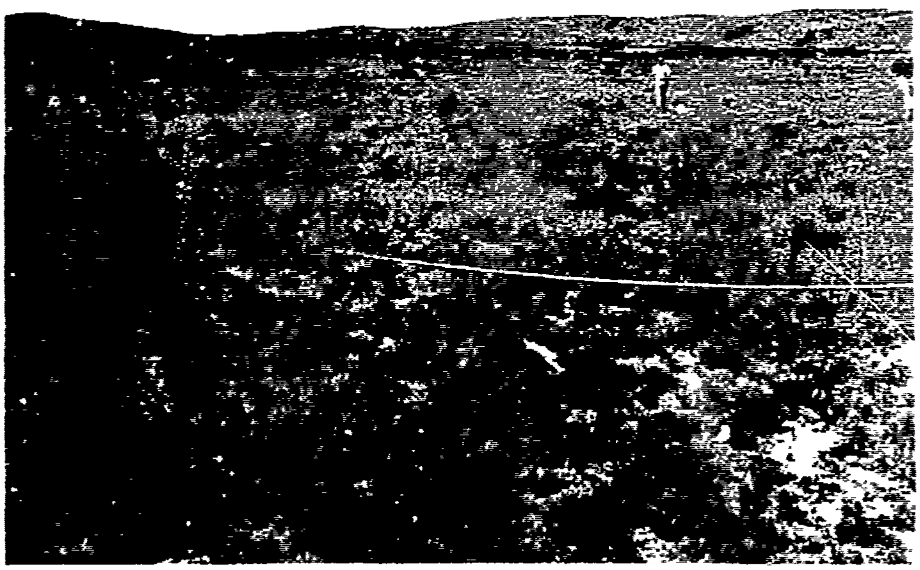


FIGURE 16. The gently sloping surface of the Otero Mesa (Landform Unit A1), looking west (Site 290). The low hills in the background are part of the A2 landform. The vegetative cover is *Bouteloua gracilis* and *Bouteloua hirsuta* with the *Bouteloua eriopoda* -- *Larrea tridentata* community (11) in the background.

FIGURE 17. The Otero Mesa escarpment with the upper alluvial fans (B1) in the foreground. The Otero Mesa slopes to the East (left) and the alluvial fans slope to the West. The plant community on the alluvial fans is *Larrea tridentata* (20).

Highly dissected hills (A2). The A2 landforms are linear in nature, trending roughly north-south. Prominent layering is apparent in the moderately to steeply dipping sedimentary rocks that form this landform subunit (figure 18). Rock types are limestone with some sandstone and shale. These landforms, comprising 16 percent of the study area, are usually lower in topographic position than A1 landforms, although in a few instances, A2 landforms are found on the Otero Mesa. The A2 landforms are distinguished from A1 landforms by their high degree of dissection and their steeper rock dip. Drainage density is high and drainageways are V-shaped. The drainage pattern is dendritic, but with some structural control. Relief is much greater than on A1 landform subunits. The large rock masses in this landform subunit are often bounded by northeast-trending faults. Inselbergs, common in this subunit, are not always fault-bounded. The A2 landforms comprise most of the Hueco Mountains and the dissected hills below the Otero Mesa escarpment in the eastern part of the study area. They occur in the western part where they form the northern and southern ends of the Franklin Mountains and the southern end of the Organ Mountains (figure 18).

FIGURE 18. Highly dissected hills Landform (A2) illustrated by this oblique aerial view of the northern portion of the Franklin mountains (near Site 140). Limestone beds are dipping about 30° to the west.

Two major rock sequences were recognized within this landform subunit from field work: interbedded limestones and shales, and bedded limestones. Although sandstone is distinctly present in some areas, it occurs with very low frequency. The limestone sequences were not identified on the 1:50,000 scale and the 1:100,000 scale aerial photography used in this study.

The sequence of interbedded limestones and shales is found mainly in the rock masses and inselbergs in the eastern part of the study area, north of the Hueco Mountains. The resistant limestones form steep slopes (> 45 percent) on the hillsides; whereas gentle slopes occur on the less resistant shale beds. An excellent example of this stair step pattern is near Broyle Tank, at sites 224 to 234, where the shale beds are accentuated by a dense grass cover (figures 7 and 14).

Soils developed on the alluvium are silty loam, silty clay, and gravelly silty clay loam. The soil depth is usually more than 30 cm, although soils depth is usually less than 15 cm on the limestone beds. Residual soils developed on the shale layers of the interbedded sequence are clay, clay loam, gravelly clay, or gravelly clay loam. Shale fragments in these soils were 1.5 cm or less in diameter, and soil depth is mostly less than 30 cm. Limestone bedrock formed the major portion of the surface in this areas, and in some places, alluvial materials were found at the base of individual limestone beds.

The bedded limestone unit, which probably contains varying amounts of dolomite, is more common throughout the study area than the interbedded sequence of limestones and shales. The bedded limestones form most of the Hueco Mountains, and the sedimentary portions of the Organ and Franklin Mountains. Both areas appear to be heavily faulted. Soils on these limestones and dolomites are primarily gravelly loams, with gravels ranging from 2.5 to 5 cm in diameter. In many steep-sloped areas, fractured bedrock was exposed, i.e. sites 260, 263, and 264, and the upland areas at site 296 (figures 7 and 14). The soils on the hillsides are usually less than 15 cm deep. At the bases of the slopes, soils forming in colluvium are deeper, ranging from 30 to 45 cm or more in depth.

Site 270, located on the bedded limestone unit, points out a frequent soil/bedrock relationship that develops on escarpments and inselbergs adjacent to the basin area in the eastern part of the study area. Sand removed from the basin was redeposited by wind on these areas. On well-established sand deposits deeper than 30 cm, plant species indicative of sandy soils rather than of limestone bedrock, such as *Artemisia filifolia* and *Sporobolus contractus*, were found.

Rugged, sharp-crested mountains (A3). This landform unit occurs as mountain ranges and occasionally as isolated blocks within other landform units. This landform unit is composed of igneous rocks, mainly andesite, rhyolite, and various granitic rock types. In some areas, the granitic rocks might be metamorphosed (figure 19). The landform is most common in the western part of the study area, where it forms large, continuous rock masses in the central part of the Franklin Mountains and most of the Organ Mountains. This landform also occurs as isolated mountainous bodies within the eastern mountainous area, such as Red Hill and Cerro Alto. The Jarilla Mountains also belong to the A3 landform unit. The crests of these igneous blocks and ranges are rough and jagged because of prominent jointing. The A3 landforms are distinguished from the A2 landforms by the lack of a linear trend, prominent layering, and their slightly darker photo tone. Relief is greater here than in the other landform units. Drainage density is sparse to moderate, as is the degree of drainageway incision. Drainageways are generally V-shaped, and the drainage pattern is dendritic. Frequently, the A3 landform units are simple intrusions that have been exposed by prolonged weathering. Some have attained their present position by faulting.

Soils on A3 landforms are rocky and very shallow, less than 15 cm (figure 19). Residual soils were usually loamy gravels and sands, and on colluvial slopes, loamy gravels. Vegetation is confined to the rock fractures, to the shallow loamy, rocky soils less than 15 cm in depth, or to the loamy soils 15 to 20 cm deep, such as at sites 261 (Red Hill) and 258 (Cerro Alto).

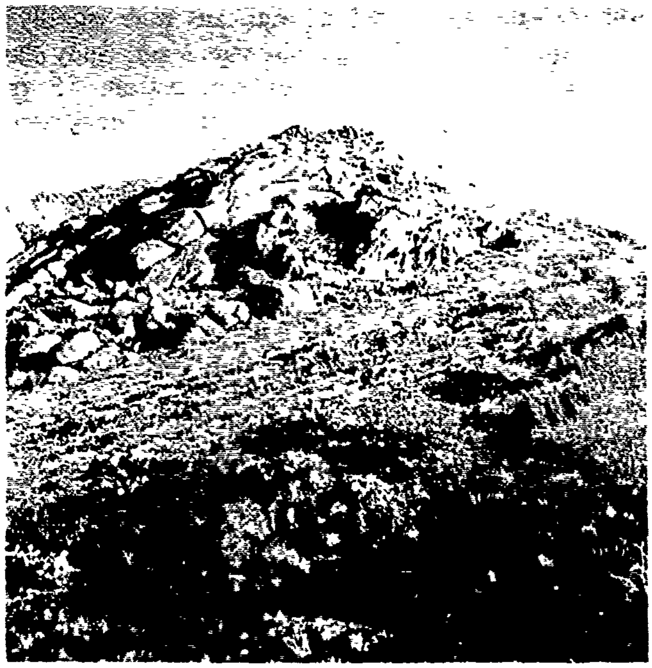


FIGURE 19. Granite outcrop in Fusselman Canyon in the Franklin Mountains (A3). The rounded, shape of the outcrop and the rocks that compose it appear as rough, sharp crests in the aerial photography.

Alluvial Fans.

Primary high elevation fans (B1). This landform subunit includes the high elevation, coarse-grained alluvial fans that are located immediately adjacent to rock masses and are formed in association with primary streams. These fans are smooth textured and have a light-to-medium photo tone. The surface drainage pattern is well developed and moderately dense. Drainageways are incised, and most of the drainage originates within the subunit. Relief is greater on these fans than on the other alluvial fan subunits. These are also the most common fan units, forming approximately 11 percent of the study area. On the western side of the study area, they form a large, continuous unit along the flanks of the Franklin and Organ Mountains. Their distribution is more discontinuous on the eastern side of the study area where they occur in two distinct locations, along the major boundary between A1 and A2 landform subunits and at lower elevations between A2 landform subunits and the B3 and B4 alluvial fans (figures 12 and 14).

Soil textures on the B1 alluvial fans were gravelly loam, gravelly clay loam, gravelly silt loam, clay, gravelly clay, gravelly sand loam, sandy clay loam, and gravelly sandy clay loam (figures 20 and 21). Soil depth ranged from 15 to 45 cm, although shallower soils were found overlying the petrocalcic horizon. The percent gravel ranged from 10 to 40 percent in most of the soil samples.

Secondary high elevation fans (B2). The B2 alluvial fans occur primarily at high elevations, are coarse grained like the B1 fans, have moderate drainage density, and often occur adjacent to rock masses. The B2 fans occasionally occur below the toes of B1 fan units. They are of smaller areal extent, occur along secondary rather than primary streams, occupy a lower topographic position than B1 fans, and are darker in photo tone than B1 fans. Most of the drainage on the B2 fan units is through flowing rather than originating within the fan. Drainageway incision is light to moderate, and relief is much less than on B1 fan units. The B2 fans comprise only 1 percent of the study area. They are located primarily on the eastern side of the study area in the dissected hills north of the Hueco Mountains, between the two sets of B1 fans (figure 14). No soil samples were collected in this landform subunit; however, the soil texture and depth should be similar to those conditions described for the B1 fans.

FIGURE 20. Upper alluvial fan (B1) near Lake Tank (Site 4). Cobble-sized rocks occur on the fan surface. The plant community is *Acacia constricta – Larrea tridentata* (31) with *Yucca baccata.*

FIGURE 21. Vertical section of a B1 fan in Pendejo wash (Site 248). Horizons of coarse gravel (a) alternate with layers of finer textured materials (b) sands and silts. Cobbles (c) and coarse gravels form the wash floor.

Mottled, intermediate elevation fans (B3). The B3 alluvial fans occur at lower elevations basinward of the B1 and B2 fan subunits, beginning where the drainage pattern becomes distributary. They are relatively large fans with low relief, but they form only 7 percent of the study area. The drainageways in these fans are rarely incised, and the drainage pattern is strongly distributary, which makes identification of specific channels almost impossible. The B3 fans are medium in overall photo tone, but white and dark grey patches are common, giving them a mottled appearance. Texture is smooth and they are finer grained than B1 and B2 fan units (figure 22).

Surface soils are mostly clay loam in texture, with some sandy loam and loamy sand soils. Surficial soils contained less than 10 percent gravel. The percent gravel increases below the surface horizon and often comprises 10 to 30 percent of the sample at depth. Soil depth is more than 30 cm and often is greater than 100 cm to a petrocalcic horizon or bedrock.

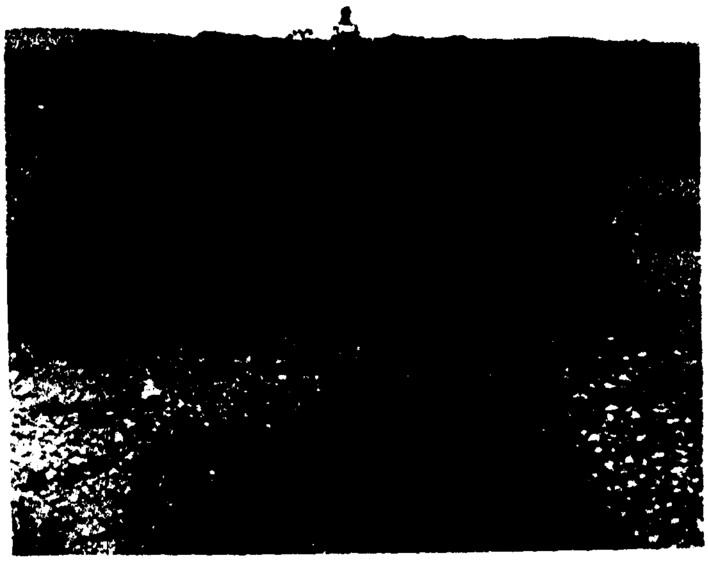


FIGURE 22. Lower alluvial fan (B3) consisting of fine sand, silt, and clay surficial materials with some gravels (Site 41). The plant community is *Larrea tridentata* -- *Muhlenbergia Porteri* (21).

Dark-toned, lowest elevation fans (B4). These are the youngest fan units in the study area and are probably undergoing development at the present time. They are located basinward of the areas of continuous rock outcrop like the B3 fans, but can extend up drainageways for a short distance. These fans are fine grained like the B3 fans, but occupy a lower topographic position. The B4 fans form broad aprons that trend north-south adjacent to the basins. Relief is not usually apparent on these fans and drainageways are very shallow and ill-defined (figure 23). Some of the drainageways can have almost vertical walls, 2 to 4 meters in height, in their upper reaches, where they come onto these fan units (figure 24). The distributary drainage pattern is faintly observable on the 1:50,000 scale photography. The B4 fans are best identified by their dark photo tone, which is caused by dense vegetation. These fans comprise approximately 4 percent of the study area.

Soils of B4 fan subunits reflect the transition between the sand dune soils of the basin areas and the fine-textured soils derived from the sedimentary rock. Surficial soils are clay, gravelly clay, gravelly clay loam, clay loam, silty clay, and sandy clay loam. Soil depth is 30 to 60 cm or more (figure 24). Precipitated carbonates or a petrocalcic horizon may occur in some areas at a depth of 30 cm.

FIGURE 23. Low alluvial fan (B4) consisting of fine-grained materials; silts, clay, and fine sands. The plant community is *Flourensia cernua* -- *Scleropogon brevifolius* (41). The Otero Mesa escarpment is seen in the background.

FIGURE 24. Vertical section (4M) of the B4 alluvial fan in Pipeline Canyon near Site 298. The upper two meters of the profile (a) is silts and clay and the lower portion (b) is loamy gravel. The wash surface is composed of cobble- and gravel-size particles.

Fans covered with deep aeolian sand (B5). This landform unit may be any of the other alluvial fan units or a combination of fan units that have been covered with aeolian sand. The sand cover is of indeterminate depth, but it is sufficient to mask the fan characteristics necessary to identify a particular fan unit. These areas are identifiable as alluvial fans because of their fan shape, their topographic position, and their moderate slope (1 to 5 percent) (figure 25). They are light in photo tone because of their sand cover and are sometimes speckled owing to the presence of shrub vegetative cover. They can be differentiated from the basin landform units by breaks in slope and elongate, slightly darker toned areas at their bases. Little or no drainage can be seen, and little local relief is found on these fan subunits. They form nearly 4 percent of the study area and are more common on the eastern side of the basin areas, particularly on the western slopes of the Jarilla Mountains.

The B5 soils are sandy clay loam and loamy sand. For the most part, these soils are aeolian and are independent of the underlying material in composition and texture. Soil depth ranged from 30 to 45 cm or more. The presence of mesquite shrubs on small dunes (1 meter tall) indicate that the alluvial fans have been sand covered for some time.

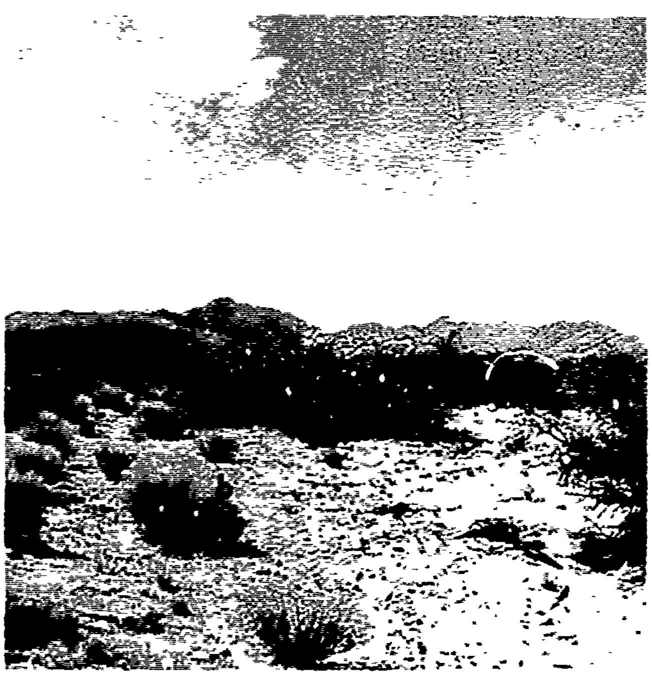


FIGURE 25. Alluvial fans (B5) covered with aeolian sands (Site 69). The shrubs are *Prosopis glanduiosa* (a) and *Xanthocephalum Sarothrae* (b).

High elevation, anomolous fans (B6). The B6 alluvial fans are located on the Otero Mesa, near the boundary between the mesa and the Sacramento Mountains. They have characterisitics in common with other fan units, and at the same time, are unlike any alluvial fans in the study area. The B6 fans occur at high elevations immediately adjacent to rock outcrops like the B1 and B2 fans; and like the B2 fans, they are secondary rather than primary fans. They appear fine textured in the aerial photography, and have gentle slopes (less than 1 percent) like the B4 fans. Incised and distributary drainageways occur side by side on the B6 fans, rather than the distributary drainage occurring downstream from moderately incised drainageways that is the situation on the other alluvial fans. Little headward erosion is evident in association with the incised drainageways. The soil textures in this fan subunit are gravelly loam and gravelly clay loam. Soil depth is more than 45 cm either to bedrock or to the petrocalcic horizon.

The B6 fans might be relatively young, slow-growing alluvial fans resulting from differential movement along the east-west fault(s) separating the Sacramento Mountains from the Otero Mesa. This fault could be a hinge fault, along which movement occurs only as a result of rapid movement on the major north-south trending faults between the Otero Mesa and the basin areas. The Sacramento Mountain/Otero Mesa boundary fault could also be independent of the faults between the Otero Mesa and the basin areas, tilting the Otero Mesa to the south. The B6 fans suggest active movement along the Sacramento Mountains/Otero Mesa boundary fault, but because these fans appear quite young, any movement on this fault is slow in comparison to that along the Otero Mesa/basin boundary faults. Regardless of the tectonic impetus for the B6 fans, they are unique in their appearance and occurrence at high elevations on the Otero Mesa.

Basin Areas.

Light-toned, speckled sand dunes (C1). This landform unit occupies most of the Hueco Bolson and the Tularosa Basin and comprises 30 percent of the study area. Local relief is very low, but it is sufficient to identify the many small sand dunes that are the characteristic feature of this landform subunit (figures 26 and 27). C1 landforms are light in photo tone, yet have an overall speckled appearance. The tiny dark spots are caused by the shrub vegetation growing on the dunes. There is a little visible drainage. The landform unit extends from the northern to the southern end of the study area and is bordered by alluvial fans coming from the mountainous areas on the east and west.

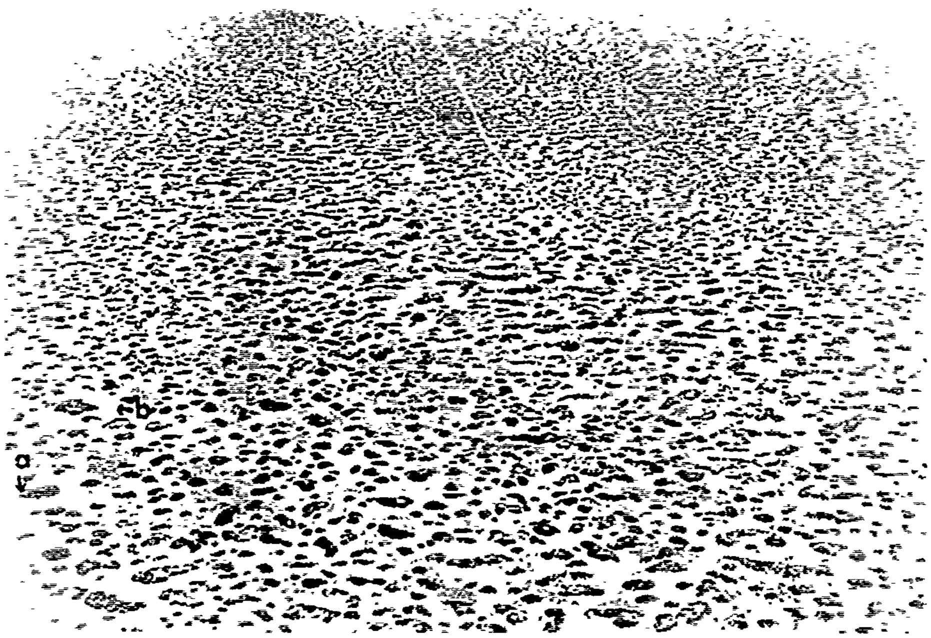


FIGURE 26. Coppice sands dunes (C1) of the Tularosa Basin are shown in this oblique aerial photograph. The large irregularly shaped dark patches are *Prosopis glandulosa* shrubs (a) on the dune crests. The lighter toned areas are barren or sparsely vegetated interdunal areas. The small dark spots are *Xanthocephalum Sarothrae* shrubs and *Sporobolus* spp. grass (b).

FIGURE 27. Profile of a coppice sand dune (C1) (Site 274). *Prosopis glandulosa* shrubs (a) are on the dune and *Sporobolus flexuosus* (b) is in the interdunal areas.

FIGURE 28. Profile in an interdunal area showing several horizons of carbonate precipitation (C).

Soils in the C1 landform unit are sandy loam, loamy sand, sandy clay loam, sandy clay, and silty clay loam. Gravel-sized particles are usually fragments of caliche formed by the cementation of smaller sized soil particles. Gravels comprise less than 3 percent of the soil sample. The caliche particles observed on the soil surface in the interdunal areas are probably lag gravels, but some may have been brought to the surface by burrowing animals or insects. Figure 28 illustrates a profile on the basin/dunal area, showing the various horizons and zones where carbonates have precipitated. Soil depth to the petrocalcic horizon ranged from 45 to 75 cm, or more. Shallow soils (less than 15 cm) were found in the deflation areas where sand has been removed almost to the depth of the petrocalcic horizon, in such areas as sites 54 and 55 (figure 7).

Most soils are sandy loam or loamy sand in texture. The small dunes are comprised mostly of sand (75 percent or more) and less than 20 percent clay-size particles. There is an increase in the percent silt plus clay fraction in the deflation areas and in some of the larger sand dunes. There appeared to be a possible relationship between the height of the dunes and the percent "fines," but verification of such a relationship would require further investigation. Few soils were found that contained more than 20 percent clay.

Dark-toned, rough-textured sand dunes (C2). Landform C2, comprising nearly 3 percent of the study area, forms a northeast-trending linear pattern adjacent to alluvial fans on the east side of the basins, particularly between the fans paralleling the dissected hills on the east and the Jarilla Mountains on the west, and at several locations on the western side of the study area. This landform subunit is composed of deep sands and sand dunes in which blowouts were often formed (figures 29 and 30). In comparison with the C1 sand dunes viewed on the aerial photography, the dunes of landform C2 are darker in overall photo tone, rougher in texture, and do not have the overall speckled appearance of C1 dunes. The overall darker tone of the C2 dunes is related to increased grass cover, and the rough appearance is caused by the small blowouts that are now covered by grasses and shrubs. Some drainageways enter the C2 unit from the surrounding alluvial fans, but they either dissipate rapidly or terminate in the low areas, or playas.

Soils in C2 landform units are loamy sands and sandy loams without gravel-sized particles. The percent sand in these soils is greater than 75 percent. Soil depth is greater than 100 cm. Soil pits dug within the landform subunit did not show evidence of a petrocalcic horizon or carbonate precipitation. Pea-size gravels of caliche are found on the surface; although they are probably lag gravels, some may have been brought to the surface by burrowing animals or insects.

FIGURE 29. Deep sands and large sand dunes near Wilde Tank (Landform C2) (Site 30). Dunes are covered by *Artemisia filifolia, Dalea scoparia,* and *Yucca elata.*

FIGURE 30. Vertical section of a road cut in the dune area of landform C2. Soils are silt and fine sand with caliche particles. The gravels in the foreground are from the road bed. The plant community is *Artemisia filifolia – Sporobolus cryptandrus* (60).

In some disturbed areas, soil depth was sufficient to form large sand blowouts (sites 28, 29, 244, and 245, figure 7). The blowouts varied in size, with the largest ones being 5 to 10 meters in diameter and 2 to 3 meters deep. The lighter photo tone associated with these sites is indicative of sparse vegetative cover. Darker tones were indicative of less disturbed areas with greater grass/shrub ground cover. The blowouts in the darker toned, more densely vegetated areas are small in size, mostly 2 to 3 meters in diameter and 1 to 1.5 meters deep.

Low smooth areas (C3). Landform unit C3 is composed of irregularly shaped, low lying, smooth areas with virtually no relief. At the photo scale 1:50,000, no dunes are recognizable and drainage cannot be discerned. The tone is slightly darker than in the C1 or C2 landform subunits. This landform, comprising 2.5 percent of the study area, occurs primarily as an east-west trending band across the southern part of the Hueco Bolson. A secondary occurrence was found between the alluvial fans on the eastern slopes of the Jarilla Mountains and parallel to the eastern mountain ranges. No soil samples were collected in landform unit C3 (figure 14).

Small, dark-toned depressions (C4). This landform subunit is composed of small, dark-toned depressions located primarily on the western side of the basin areas, and forms nearly 2 percent of the study area (figure 31). Photo tone is often mottled, and many of the depressions have light-toned rings around their edges. The depression shape was variable, ranging from round to channel-like or kidney-shaped depressions. Small drainage channels are sometimes visible running into them, and several of the depressions contain playa lakes.

Soils in landform unit C4 are sandy loam, loamy sand, sandy clay loam, and clay. Gravel-sized particles usually composed less than 5 percent of the samples; however, some samples contained 8 percent gravel. Soil depth is greater than 60 cm at most sample sites. Precipitated carbonates were identified in the profile, although a definite cemented horizon had not developed in the 60-cm soil profile.

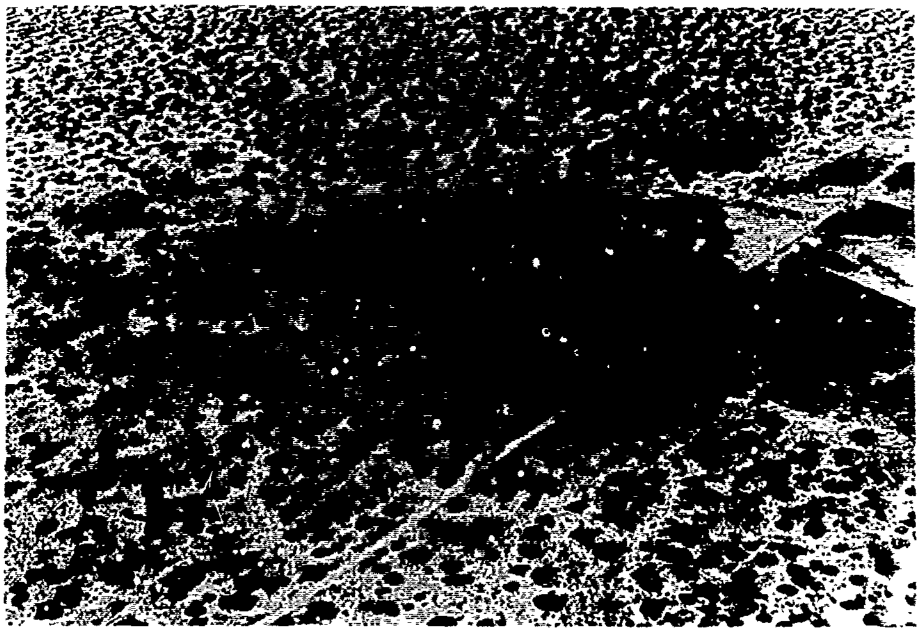


FIGURE 31. Small playa lake in the Tularosa Basin (C4). The playa is the large dark toned area outlined in the photo. The dark tone is caused by an increased grass cover resulting from the favorable moisture conditions in the depression. The grasses are *Hilaria mutica, Scleropogon brevifolius,* and *Muhlenbergia* spp.

Washes. Two types of drainageways occur within the study area; (1) washes or V-, U-, or box-shaped gullys that are easily recognized on the aerial photography by their incisement and location in the mountains/hills and upper alluvial fan landforms, and (2) streamlets in the distributary drainage pattern areas of the lower alluvial fans. The washes delineated on figures 12, 13, and 14 are of the first type. They generally extend only to the boundary between the uplands and the heads of the lower alluvial fans (B3 and B4), but some enter the fan complex, extending into them for a short distance. Several washes extend through the fan complex, such as the one in Pipeline Canyon, near site 298 (figure 7).

The streamlets in the distributary parts of the drainage pattern on the alluvial fans are very difficult to identify, both on the aerial photography and in the field because of their small size. However, streamlets on the B4 fans were easily identified in the field because they are covered with patches of dense grass that alternate with bare ground. Once the ground pattern was associated with the photo pattern alternating patches of dark photo tone (grass) and light photo tone (bare ground), the photo identification was much easier. Although washes could be identified, the individual streamlets could not be. These drainlets are generally less than 15 cm deep and are 1 to 5 meters wide.

Streamlets on the B3 fans were difficult to identify. They are about 0.3 meters deep and 1 meter wide. In the field they can sometimes be distinguished from the surrounding fan surfaces because they have a more extensive cover of gravel. Their courses are often marked by mesquite (*Prosopis glandulosa*) shrubs that contrast in color with the creosote (*Larrea tridentata*) on the fan surface. However, these features were not seen on the 1:50,000 scale aerial photography.

The texture of the surficial material in the washes changed, depending upon the portion of the wash considered. In the upper reaches, the surficial materials are cobbles and coarse gravels with some boulder-sized material. Figures 21 and 24 show these course-textured materials. Vegetation in the upper reaches is confined to the borders of the channel or to areas of higher elevation within the channel. The vegetation cover is composed primarily of shrub species with some grass species. In some upper reaches, the drainageways were filled with fine sand, silt, and clay-size material. The fine-textured soils are covered with a dense cover of *Sporobolus giganteus.* Field observations showed these drainageways were impassable to vehicle traffic because of the gulch type erosion that had dissected the surface material. The gulches were often 1 meter deep and 1 to 4 meters wide.

In the lower and middle reaches of the washes, the surficial materials consisted of sand, silt, and clay-size particles, with little or no gravel. The surficial soils are clay, clay loam, silty clay, or clay. At site 271, the 4-meter profile exposed in the drainageway is fine sandy clay loam throughout, yet the wash bottom is covered with gravels 2.5 cm or smaller in diameter. Vegetation in these parts of the washes is primarily grasses.

The general relationships between landform and soil texture and soil depth are summarized by landform subunit in table 4. More detailed information on landform and soil relationships is presented in appendix C.

TABLE 4. Landform, Soil texture and Soil Depth Relationships.

Landform	Soil Texture	Soil Depth
A1	clay loam with gravel	up to 45 cm where the slope is less than 3%; up to 30 cm on steeper slopes
	exposed bedrock	— — —
A2	colluvial on shale: silty loam, silty clay, gravelly silty clay	usually more than 30 cm, but sometimes less than 15 cm
	residual on shale: clay, clay loam, gravelly clay, gravelly clay loam	less than 30 cm
	on bedded limestones: gravelly loam	usually less than 15 cm, but up to 30 to 45 cm or more
	exposed bedrock	— — —
A3	residual: loamy gravel, sand	less than 15 cm
	colluvial: loamy gravel	15 to 20 cm
B1	Gravelly loam, gravelly clay loam, gravelly silt loam, clay, gravelly clay, gravelly sand loam, sandy clay loam, gravelly sandy clay loam	15 to 45 cm
B2	NO SOIL SAMPLES, but similar to B1 soil conditions.	
B3	clay loam, sandy loam, loamy sand	more than 30 cm, sometimes more than 100 cm
B4	clay, gravelly clay, gravelly clay loam, clay loam, silty clay, sandy clay loam	30 to 60 cm or more

TABLE 4. (Continued)

Landform	Soil Texture	Soil Depth
B5	sandy clay loam, loamy sand	30 to 45 cm o• more
B6	gravelly loam, gravelly clay loam	more than 45 cm
C1	sandy loam, sandy clay loam, sandy clay, silty clay loam	more than 75 cm on dunes, can be less than 15 cm in interdunal areas
C2	loamy sand, sandy loam	more than 75 cm and sometimes more than 100 cm
C3	NO SOIL SAMPLES, but similar to soil conditions of C1.	
C4	sandy loam, loamy sand, sandy clay loam, clay	more than 60 cm
D	Upper reaches: gravel, cobbles. boulders	— — —
	Middle and lower reaches: clay, clay loam, silty clay	— — —

PLANT COMMUNITES. Sample sites were located in the different land cover units that differed in their photo tones and textures. These differences were assumed to depict discrete plant communities. Phytosociological data describing the plant communities of the land cover units were collected in 294 sample quadrants (appendix D). Analysis of the clustered phytosociological data using the "Phyto 69" computer program identified four major land cover categories; grassland, shrubland, forestland, and other (table 5). The first three major categories were subdivided into 22 plant associations by the physiognomic character of the dominant plant species, the species composition, and the ground cover class of each plant species. The terms "plant community" and "plant associations" are used interchangeably in this report. The fourth land cover category, Other, and its three subunits – urban and built-up areas, water bodies, and bare ground – are discussed only in general terms because this category delineates nonvegetated areas.

The phytosociological data from the quadrants for each plant association were summarized and the average cover class, absolute frequency, and the relative frequency of each species in the plant community (land cover unit) were determined (appendix F). The clustered phytosociological data and the plant association summaries formed the base from which the dominant and the associate plant species characterizing a plant community were determined. To validate these plant associations, one calculated similarity coefficients between the 22 plant communities. The similarity coefficients are numerical representations of the similarity and dissimilarity in the species composition between two plant communities. The similarity coefficients were determined by the following equation:

$$SC = 2W/(A + B) \tag{7}$$

where W equals the sum of the smallest relative frequency percentage for a species found in both community A and community B, and where A and B equal the sum of the relative frequency percentages for all plant species found in community A and community B, respectively. Large similarity coefficients, those approaching 1.0, would represent two similar communities, and small coefficients, those approaching 0.0, would represent two discrete communities. All similarity coefficients for the grassland, grass-shrubland, shrub-grassland, and shrubland communities identified in this study are shown in table 6. The similarity values ranged from 0.03 to 0.81.

TABLE 5. Land Cover Mapping Units and Their Percentages of the Study Area.

Physiognomic Group	Group Percent of Area	Land Cover Unit	Percent of Area
Grassland	37.4		
		Grassland (10)	21.1
		Grass-*Larrea tridentata* (11)	0.7
		Grass-*Flourensia cernua* (12)	1.3
		Grass-*Acacia constricta* (13)	< 0.1
		Grass-*Artemisia filifolia* (14)	0.7
		Grass-*Prosopis glandulosa* (15)	2.2
		Grass-*Parthenium incanum* (16)	11.3
Shrubland	58.2		
		Larrea tridentata (20)	9.6
		Larrea tridentata-Grass (21)	4.6
		Larrea tridentata-Grass-*Parthenium incanum* (22)	0.6
		Larrea tridentata-Prosopis glandulosa-Grass (23)	4.1
		Larrea tridentata-Flourensia cernua-Grass (25)	2.4
		Acacia constricta-Grass (30)	1.2
		Acacia constricta-Larrea tridentata-Grass (31)	0.8
		Flourensia cernua-Grass (40)	< 0.1
		Flourensia cernua-Larrea tridentata (41)	2.2
		Prosopis glandulosa-Atriplex canescens- Xanthocephalum Sarothrae-Grass (50)	27.5
		Prosopis glandulosa-Larrea tridentata-Grass (51)	0.9
		Prosopis glandulosa-Artemisia filifolia-Grass (52)	0.7
		Artemisia filifolia-Grass (60)	2.8
		Artemisia filifolia-Prosopis glandulosa-Grass (61)	0.7

TABLE 5. Continued

Physiognomic Group	Group Percent of Area	Land Cover Unit	Percent of Area
Forestland	2.2		
		Juniperus monosperma-Quercus undulata (70)	2.2
Other	2.3	Bare ground (90)	0.2
		Water bodies (91)	0.1
		Urban and built-up areas (92)	2.0
Total	100.1		100.1

The plant communities in table 6 have been clustered to show association between these communities. These data and the clustered phytosociological data (appendix E) show that the grassland category (10) contained several grassland communities (10A, 10B, 10C, 10D) in which the species composition was sufficiently different so that separation as distinct communities was warranted. This statistical evaluation of the floristic data of each community shows that the clustered vegetation data were correctly grouped into discrete plant communities. An analysis of the field-derived vegetation data and the photo tones and textures shows that most plant communities were correlated with specific photo tones and textures. It should be pointed out that establishing these relationships required the refinement of the initial vegetation mapping efforts after data collection and analysis and again after field verification of the vegetation map. The results of this effort showed that most plant communities can be mapped directly from the aerial photography, once the relationships between the photo tones and textures and the plant community type have been established. The *Acacia constricta*-Grass (30), *Acacia constricta – Larrea tridentata* (31), and the *Larrea tridentata* (20) communities had photo tones and textures that were too similar to be separated on the aerial photography. Their separation and mapping were based on ground truth data from known sites and their association with specific landform conditions. Similarly, the differentiation between the grass communities, 10C and 10E, and the grass and shrub communities, 10C, 12, and 40, on the lower alluvial fan (B3 and B4) and the Wash (D) landform units was based on ground truth data and landform conditions because no distinct photo patterns differentiating them were found on this imagery.

TABLE 6. Similarity Coefficients for Grassland and Shrubland Communities.

	Plant Community Number																
	15	60	61	10D	50	14	52	51	10C	12	40	41	25	23	20	11	21
15	1.00																
60	.50	1.00															
61	.51	.64	1.00														
10D	.58	.64	.59	1.00													
50	.49	.47	.62	.64	1.00												
14	.54	.66	.71	.63	.61	1.00											
52	.44	.56	.81	.57	.68	.73	1.00										
51	.39	.25	.52	.42	.63	.50	.64	1.00									
10C	.17	.15	.10	.17	.17	.14	.12	.21	1.00								
12	.07	.10	.03	.13	.13	.10	.10	.23	.62	1.00							
40	.25	.20	.18	.32	.32	.26	.27	.32	.58	.66	1.00						
41	.34	.30	.39	.44	.39	.36	.47	.54	.27	.48	.54	1.00					
25	.24	.23	.23	.30	.31	.27	.26	.46	.39	.56	.57	.69	1.00				
23	.44	.30	.47	.44	.56	.41	.43	.70	.29	.34	.37	.54	.63	1.00			
20	.26	.23	.37	.37	.37	.31	.41	.63	.28	.30	.35	.49	.54	.68	1.00		
11	.47	.29	.21	.34	.30	.19	.19	.29	.35	.28	.36	.38	.49	.49	.43	1.00	
21	.15	.19	.24	.28	.29	.25	.24	.48	.35	.36	.36	.42	.55	.65	.62	.52	1.00
22	.29	.25	.24	.37	.33	.26	.22	.43	.29	.28	.29	.40	.55	.62	.57	.58	.61
16	.27	.24	.20	.29	.26	.15	.19	.28	.32	.19	.28	.33	.42	.39	.37	.54	.38
13	.30	.28	.21	.33	.32	.19	.24	.26	.35	.21	.28	.27	.36	.39	.41	.53	.40
30	.25	.26	.22	.32	.28	.17	.23	.27	.37	.25	.34	.29	.45	.41	.44	.49	.41
31	.16	.23	.18	.23	.27	.15	.16	.30	.38	.40	.39	.41	.56	.47	.47	.52	.5[illegible]
10B	.30	.24	.13	.26	.24	.13	.13	.20	.27	.17	.24	.25	.37	.33	.36	.57	.3[illegible]
10A	.43	.27	.19	.26	.28	.21	.17	.24	.35	.17	.32	.31	.33	.34	.31	.58	.3[illegible]
10	.50	.45	.34	.50	.45	.35	.30	.30	.42	.26	.43	.40	.52	.46	.39	.63	.3[illegible]

Number

23	20	11	21	22	16	13	30	31	10B	10C	10
1.00											
.68	1.00										
.49	.43	1.00									
.65	.62	.52	1.00								
.62	.57	.58	.61	1.00							
.39	.37	.54	.38	.57	1.00						
.39	.41	.53	.40	.46	.56	1.00					
.41	.44	.49	.41	.53	.62	.69	1.00				
.47	.47	.52	.52	.59	.57	.64	.64	1.00			
.33	.36	.57	.32	.47	.67	.61	.53	.57	1.00		
.34	.31	.58	.34	.38	.50	.50	.42	.40	.54	1.00	
.46	.39	.63	.39	.50	.61	.57	.60	.53	.63	.62	1.00

2

The spatial distribution of the 25 land cover unit types within the study area is shown in figures 32, 33, and 34. Statistics describing the areal extent of each land cover unit were determined using the line intersection sampling method in which 6,033 points were sampled on the three photo mosaics. The areal extent of each land cover unit is presented in table 4. These data show that the shrub communities were the major physiognomic group on 58 percent of the study area; grasslands, on 37 percent; forestland, on 2 percent; and urban and built-up areas, on 2 percent. The two shrub species, *Prosopis glandulosa* and *Larrea tridentata,* were the dominant shrub species. The communities dominated by these two shrub species covered about 50 percent of the study area. The grassland communities occurred over 37 percent of the study area and were dominated by *Bouteloua eriopoda, B. curtipendula, B. gracilis, Sporobolus cryptandrus,* and *S. flexuosus.* The other shrub communities in the study area were dominated by *Artemisia filifolia,* 4 percent; *Flourensia cernua,* 2 percent; or *Acacia constricta,* 2 percent.

Plant communities covering about 10 percent or more of the study area were *Prosopis glandulosa – Xanthocephalum Sarothrae – Atriplex canescens* – Grass (50), 27.5 percent; Grassland (10), 21.1 percent; Grass – *Parthenium incanum* (16), 11.3 percent; and *Larrea tridentata* (20), 9.6 percent. Nine other plant communities covering from 1 to 5 percent of the study area were *Larrea tridentata* – Grass (21), 4.6 percent; *Larrea tridentata – Prosopis glandulosa* – Grass (23), 4.1 percent; *Artemisia filifolia* – Grass (60), 2.8 percent; *Larrea tridentata – Flourensia cernua* – Grass (25), 2.4 percent; Grass – *Prosopis glandulosa* (15), 2.2 percent; *Juniperus monosperma – Quercus undulata* (70), 2.2 percent; *Flourensia cernua – Larrea tridentata* (41), 2.2 percent; grass – *Flourensia cernua – Larrea tridentata* (12), 1.3 percent; and *Acacia constricta* – Grass (30), 1.2 percent. The remaining nine plant communities each occupied less than 1 percent of the study area.

The 22 plant communities identified and mapped in the study area and the phytosociological data for each sample site are summarized by plant community in appendix F. A listing of the plant species found during this study as well as those reported by Kenmatsu and Pigott[36] as occurring on the Ft. Bliss reservation and environs are presented in appendix G.

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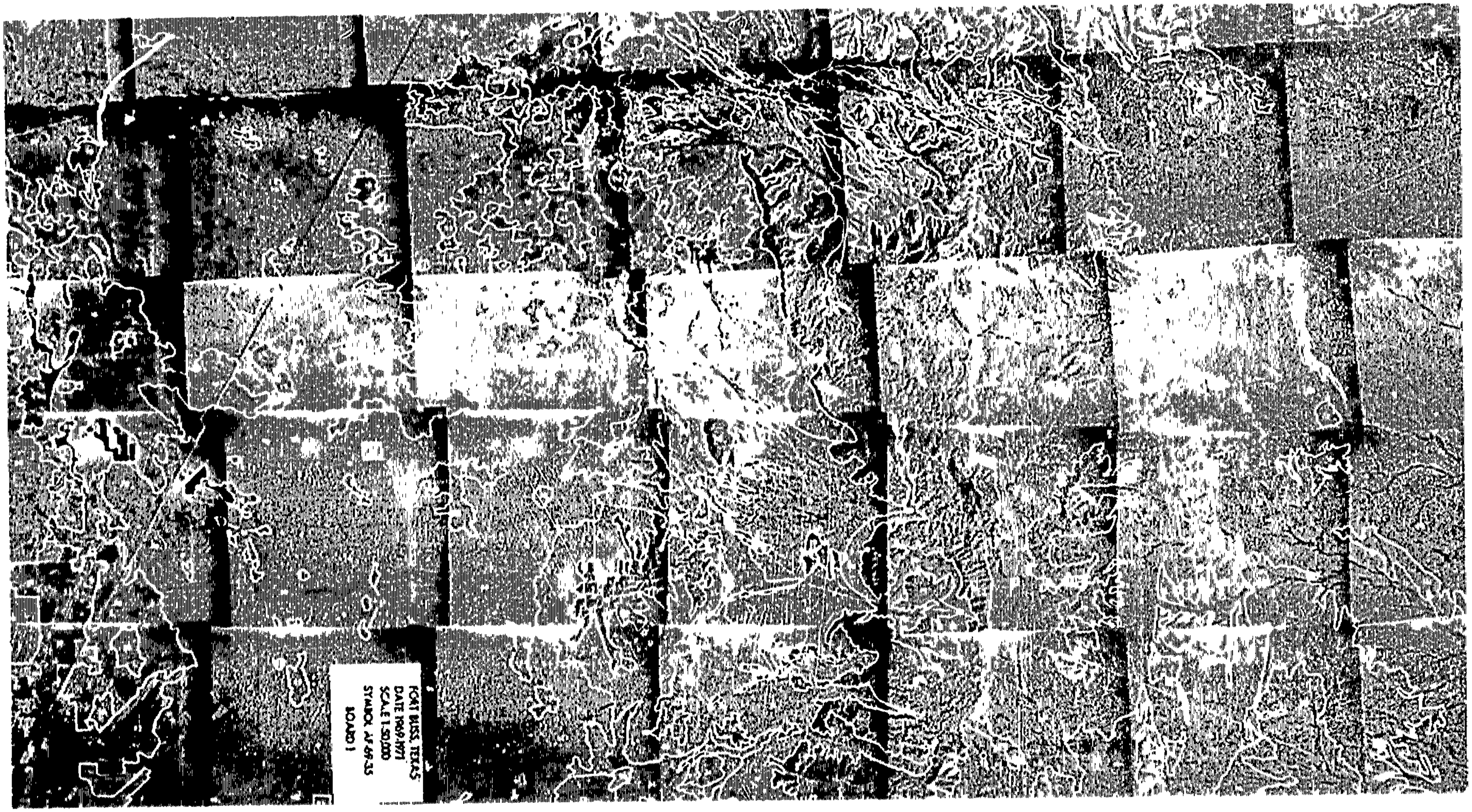
[36]R.D. Kenmatsu and J.D. Pigott, *A Cultural Resources Inventory and Assessment of McGregor Guided Missile Range, Otero County, New Mexico.* Part III. Botanical and Geological Studies. Tex. Archeological Survey Research Report No. 65:III, University of Texas, Austin, TX.



Scale: 1:270,000

FIGURE 32 Land Cover Map of the Study Area (Photomosaic 1)

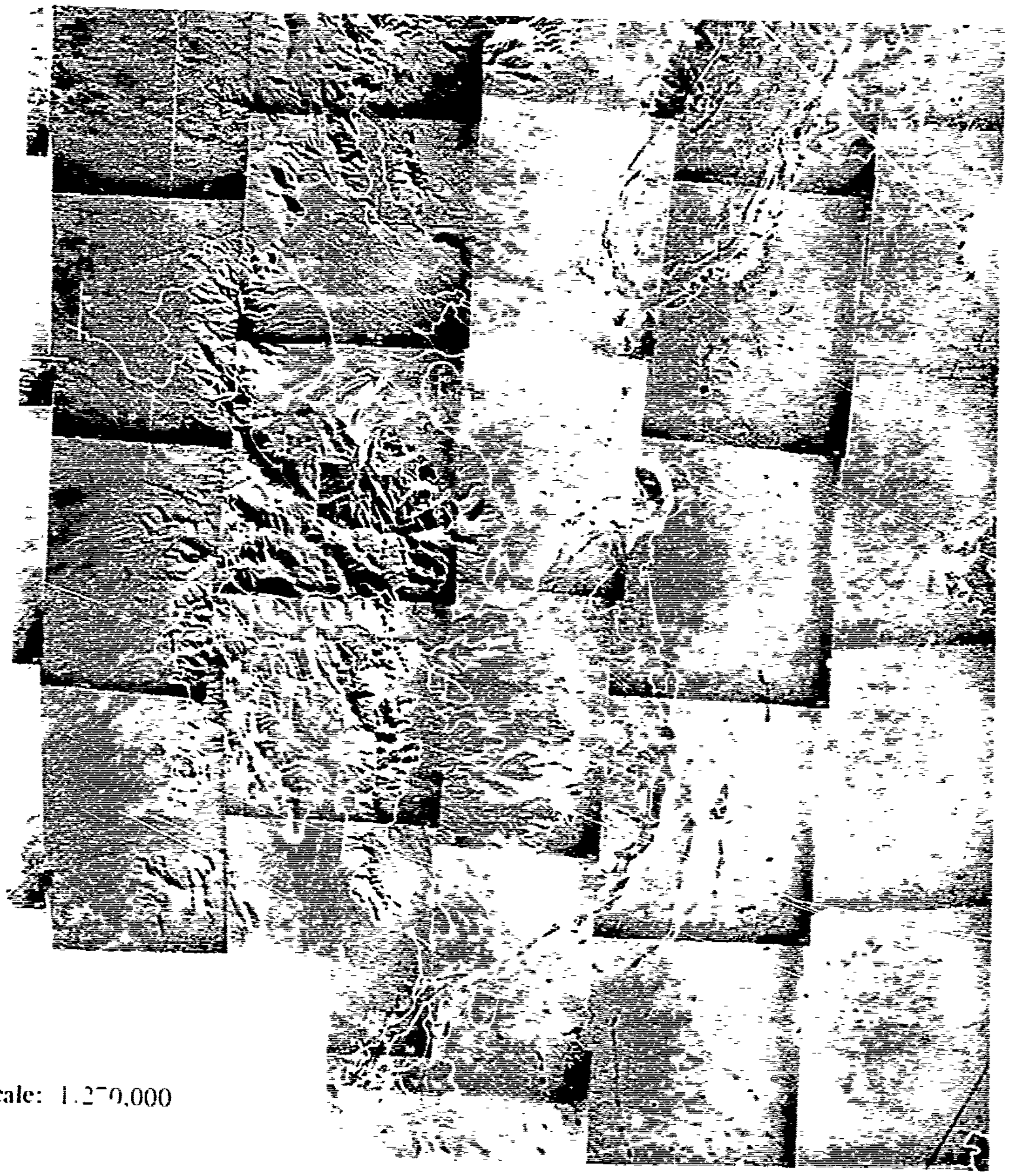


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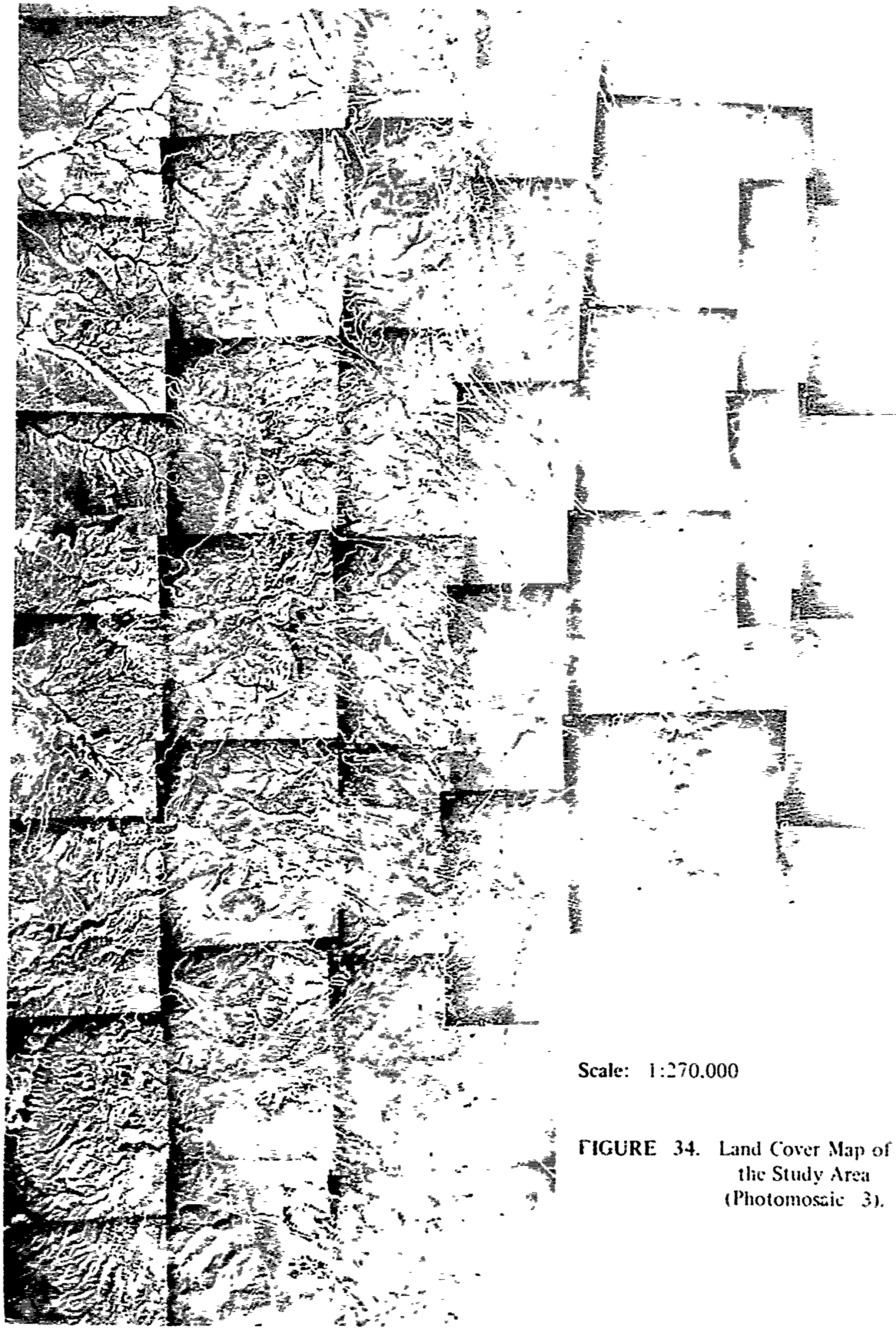
FIGURE 33. Land Cover Map of the Study Area (Photomosaic 2).



Scale: 1:270,000

FIGURE 34. Land Cover Map of the Study Area (Photomosaic 3).

Grasslands. Grasslands were widely distributed throughout the study area, occurring on most landform units and comprising about 37 percent of the land cover. The major grassland communities were on the Otero Mesa, the butte near Campbell Tank, the dissected hills of the Hueco Mountains, and along the Otero Mesa escarpment. Smaller grasslands were found on the lower and flatter portions of the drainageways, on some alluvial fans, and in the Hueco Bolson and the Tularosa Basin (figures 32, 33, and 34). The grasslands were mapped as a single land cover unit, although different grassland communities were found on different soils and landform conditions. The summary data presented for the grassland mapping unit (10) were divided into five grassland communities from analysis of the phytosociological data (appendix E). The five discrete grassland communities found in the study area are: (A) *Bouteloua eriopoda – Bouteloua curtipendula*, (B) *Bouteloua curtipendula – Bouteloua uniflora*, (C) *Scleropogon brevifolius – Hilaria mutica*, (D) *Sporobolus cryptandrus – Sporobolus flexuosus*, and (E) *Sporobolus giganteus*. Each of these grassland communities was not mapped because of the limited areal extent of each community, the inability to differentiate accurately between the communities on the aerial photography, and the small scale of the aerial photography. Although the *Bouteloua eriopoda – Bouteloua curtipendula* community could have been differentiated from the *Scleropogon brevifolius – Hilaria mutica* community based on photo tone and texture differences, the specific community identification was not possible from the photos without the ground data and the associations developed between plant communities, specific photo tones and textures, sampling sites, and landform conditions.

Shrub species frequently occurred as scattered individuals in the grassland communities; however, the shrub component in these communities had less than 1 percent ground cover. When specific shrubs occurred with ground covers of 1 to 5 percent, a separate grass-shrub community was identified. The identification of both grass-shrub and shrub-grass communities helped to avoid phenological disparities between the grass-shrub and shrub-grass community types because of the seasonal and/or annual climatic differences that might have affected the quantitative phytosociological data and change the physiognomic emphasis for naming and describing a particular community.

Grassland (10). The grassland community (10) has a rather diverse complement of grass and shrub species, some of which have narrow site requirements. The soil textures in these communities were sandy loam, sandy clay loam, gravelly loam, gravelly silt loam, gravelly clay loam, silty clay, and clay. Soil depth ranged from less than 15 cm to greater than 1 meter. These grass communities, identified in the field and from the phytosociological data, are discussed by specific grass community to describe accurately their associations with various soil and landform conditions.

A. *Bouteloua eriopoda* – *Bouteloua curtipendula* (10A).

This plant community was found primarily on the Otero Mesa and on the upper alluvial fans abutting the Otero Mesa escarpment where soil depths were greater than 30 cm deep (figures 34 and 35). The dominant grass species in this community was *Bouteloua eriopoda*, with *B. curtipendula* and *B. gracilis* as subdominant or associate species. Other grass species that were infrequently present and had ground cover values of 1 to 5 percent were *Hilaria mutica*, *Muhlenbergia arenacea*, *M. setifolia*, *Sporobolus cryptandrus*, *S. flexuosus*, and *Tridens muticus*. In some drainageways on the Otero Mesa, *B. gracilis* and *B. hirsuta* were co-dominant species, and *H. mutica* and *Panicum obtusum* were associate species. Occasionally, *H. mutica* and *P. obtusum* formed small, dense single species stands.

Shrub species were less frequently present (absolute frequency of 40 to 60 percent) and usually had ground covers less than 1 percent. The associate shrubs were *Berberis trifoliolata*, *Eurotia lanata*, *Krameria glandulosa*, *Larrea tridentata*, *Parthenium incanum*, *Viguiera stenoloba*, *Xanthocephalum Sarothrae*, and *Yucca elata*

Soil depth in this community was usually greater than 30 cm. Soil textures can be clay, clay loam, or sandy clay loam with less than 20 percent gravel or gravelly clay loam.

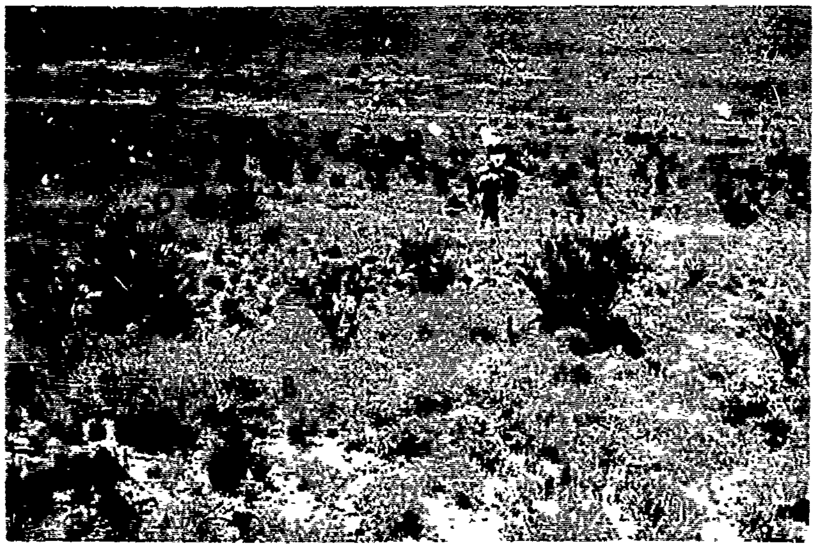


FIGURE 35. *Bouteloua eriopoda* -- *Bouteloua curtipendula* Grassland (10A) on the Otero Mesa (Landform A1). Sites 285 and 286. The scattered shrubs are *Larrea tridentata* (L), *Yucca elata* (Y), *Opuntia* spp. (O), and *Xanthocephalum Sarothrae*

B. *Bouteloua curtipendula* -- *Bouteloua uniflora* (10B).

The dominant plant species in this community were *Bouteloua curtipendula* and *B. uniflora.* Each species had ground cover values ranging from 26 to 50 percent (figure 36). *B. eriopoda* was infrequently an associate species and, when present, had ground cover ranging from 1 to 6 percent. Other associate grass species frequently present were *Muhlenbergia arenacea, M. setifolia,* and *Sporobolus cryptandrus.* Shrub species were common in this community, but the ground cover values for the shrub species were less than 5 percent in most instances Shrub species occurring infrequently were *Dyssodia acerosa, Ephedra sp., Fouquieria splendens, Krameria glandulosa, Larrea tridentata,* and *Parthenium incanum.*

This community was found primarily along the Otero Mesa escarpment, on inselbergs, the dissected hills, and the upper alluvial fans where the soils were shallow (less than 15 cm in depth) to limestone bedrock or the petrocalcic horizon Soils developing on unconsolidated material or forming on limestone parent material were gravelly clay loams in texture.

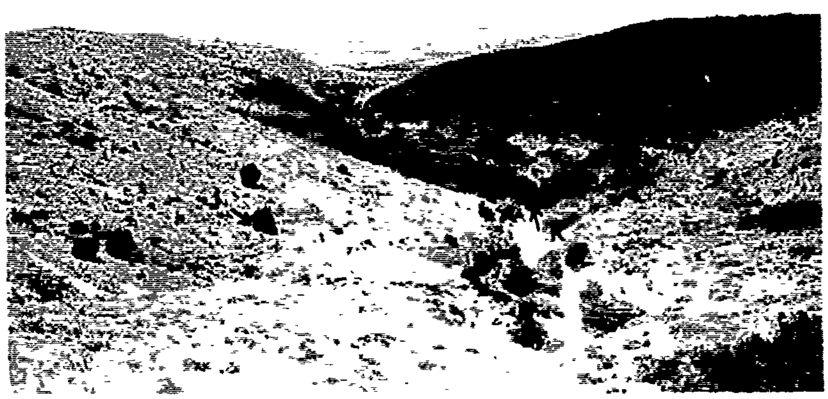


FIGURE 36. *Bouteloua curtipendula – Bouteloua uniflora* Grassland (10B) at Owl Tank Draw (A2). The trees in the drainageway are *Juniperus monosperma, Quercus undulata, Rhus microphylla,* and *Berberis trifoliolata.*

C. *Scleropogon brevifolius* – *Hilaria mutica* (10C).

Scleropogon brevifolius and *Hilaria mutica* were co-dominant grass species, occurring frequently together. Both species frequently formed dense single species stands (figure 37). Although the percent ground cover for these grasses ranged from 25 to 100 percent, the ground cover usually ranged from 25 to 50 percent. *Panicum obtusum* was an infrequent associate grass species, with a ground cover ranging from 6 to 35 percent, although at some sites the ground cover ranged from 50 to 75 percent. Within this grass community, *P. obtusum* occurred on the more moist sites, such as around catch basins. cattle watering tanks, playas, and in the drainageways.

Shrubs were usually absent from this community, but when they did occur, they accounted for up to 1 percent ground cover. The shrub species observed were *Acacia constricta, Atriplex canescens, Flourensia cernua, Koeberlinia spinosa, Larrea tridentata, Opuntia* spp., *Parthenium incanum, Prosopis glandulosa, Rhus aromatica, Xanthocephalum Sarothrae,* and *Yucca elata.*

The *Scleropogon brevifolius-Hilaria mutica* community occurred on the dissected hills, the drainageways, the alluvial fans, the washes, and the depressions in the basin areas (figure 36). This community was confined primarily to the silty clay and clay soils, where soil depth was more than 30 cm. The percent gravel in these soils was usually less than 3 percent except for soils developed on the dissected hills, which could contain 13 to 19 percent gravel. The community also occurred on some clay soils developed on the interbedded limestones and shales that form the inselbergs and escarpments between the Otero Mesa and Route 54 (figures 31 and 33). The clay soils contained 10 to 15 percent gravel (mostly as shale fragments), 70 percent clay, and 15 percent silt. In the basin areas, the community occurred in the depression areas on clay and clay loam soils with little or no gravel-size particles.

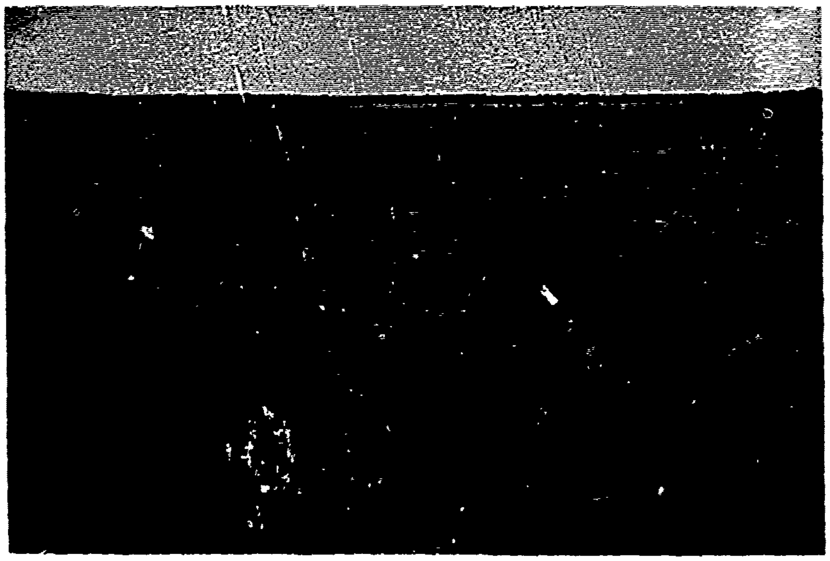


FIGURE 37. *Scleropogon brevifolius – Hilaria mutica* Grassland (10C) in a Playa (Landform unit C4). Site 277.

D. *Sporobolus cryptandrus – Sporobolus flexuosus* (10D).

Sporobolus cryptandrus and *S. flexuosus* were the dominant plant species in this community, comprising 6 to 25 percent ground cover (figure 38). *S. contractus* was an occasional associate species, with ground cover less than 5 percent. Other grass species rarely found in this community were *Bouteloua curtipendula, B. eriopoda, Chloris virgata, Setaria macrostachya,* and *Tridens muticus.* These species had ground covers ranging from 6 to 25 percent.

Several shrub species with ground cover less than 1 percent were infrequently present in the community. The associate shrub species were *Artemisia filifolia, Atriplex canescens, Dalea formosa, Ephedra* sp., *Prosopis glandulosa, Xanthocephalum Sarothrae,* and *Yucca elata.*

The community was found predominantly in the Hueco Bolson and the Tularosa Basin on medium to very fine sandy loams and on sandy clay loams that were 50 cm or more in depth. Occasionally, gravels composed of cemented sand grains were present.

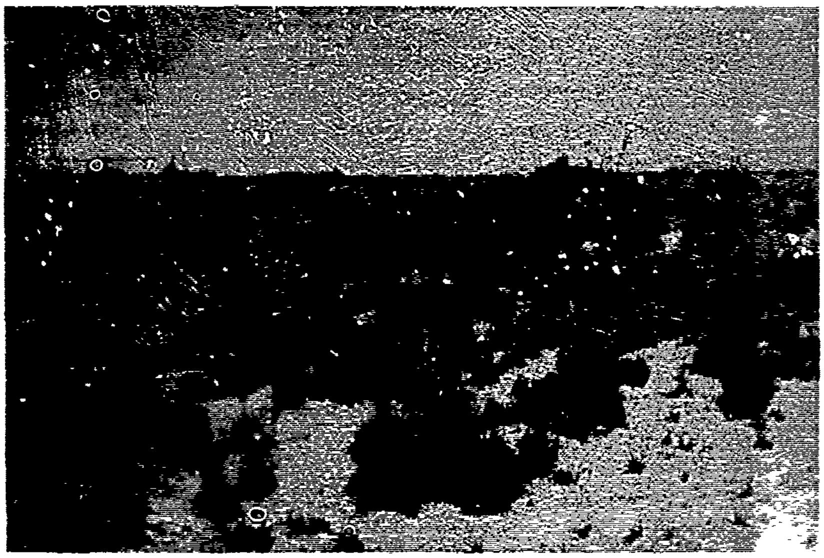


FIGURE 38. *Sporobolus cryptandrus – Sporobolus flexuosus* Grassland (10D) with *Prosopis glandulosa* (P) and *Yucca elata* (Y) shrubs. (Landform unit C1). Site 274.

E. *Sporobolus giganteus* (10E).

Sporobolus giganteus formed a dense vegetative cover, with 50 to 75 percent ground cover, that was 1.5 to 2 meters tall (figure 39). Shrub species were occasionally associated with *S. giganteus*, but they were present with ground covers less than 1 percent. The associate plant species were the grasses *Muhlenbergia arenacea, S. Wrightii, Tridens muticus*, and the shrub species *Flourensia cernua, Larrea tridentata*, and *Prosopis glandulosa* (site 179, figure 33).

In the lower reaches of the washes that originate at the Otero Mesa escarpment between Route 506 and McGregor Range camp, *S. giganteus* forms a very dense, almost homogenous, plant community in the deep (greater than 1 meter) clay loam soils. This plant community was distinctive because stream flow had cut many small drainageways through the community, forming a rill-type drainage pattern. The size of the rills varied, ranging from 0.15 to 1.5 meters deep and from 2 to 3 meters wide. The dissected nature of the clay loam soils in the drainageways has created a grass-hummocky aspect visible only on the ground. This community grades rather abruptly into the *Scleropogon brevifolius – Flourensia cernua* community at lower elevations, along a line that almost parallels the small escarpment along the western edge of the dissected limestone formation below the Otero Mesa escarpment, i.e. at Lee Tank.

Soils in the *S. giganteus* grassland were primarily clay loam in texture with essentially no gravel and were greater than 1 meter in depth.

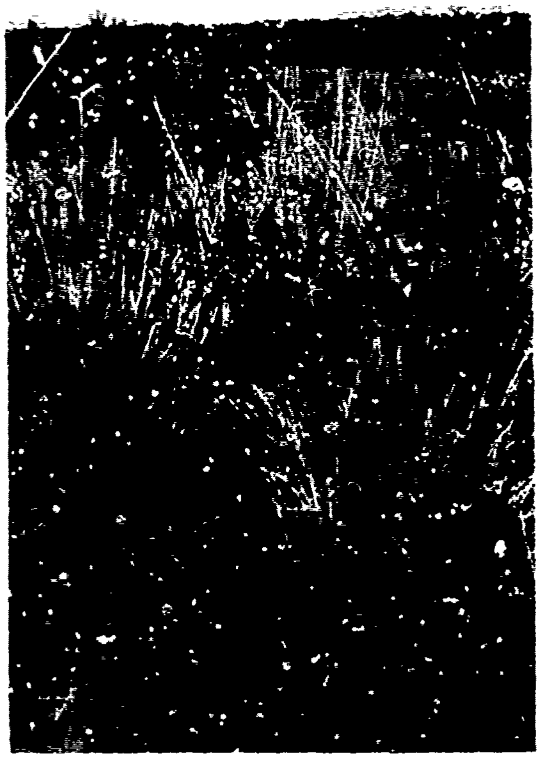


FIGURE 39. *Sporobolus giganteus* Grassland (10E) in the midreach of a wash (Landform D). Site 179.

Grass – *Larrea tridentata* (11). This grassland community was comprised of several grass species, with ground covers ranging from 25 to 75 percent. These were *Bouteloua curtipendula*, ` *eriopoda*, *B. gracilis*, *Hilaria mutica*, *Muhlenbergia arenacea*, *M setifolia*, and *Scleropogon brevifolius*. The associate grass species were *B. hirsuta*, *M. Porteri*, *Sporobolus Wrightii*, and *Tridens muticus*, which had ground cover values ranging from 1 to 5 percent (figure 40).

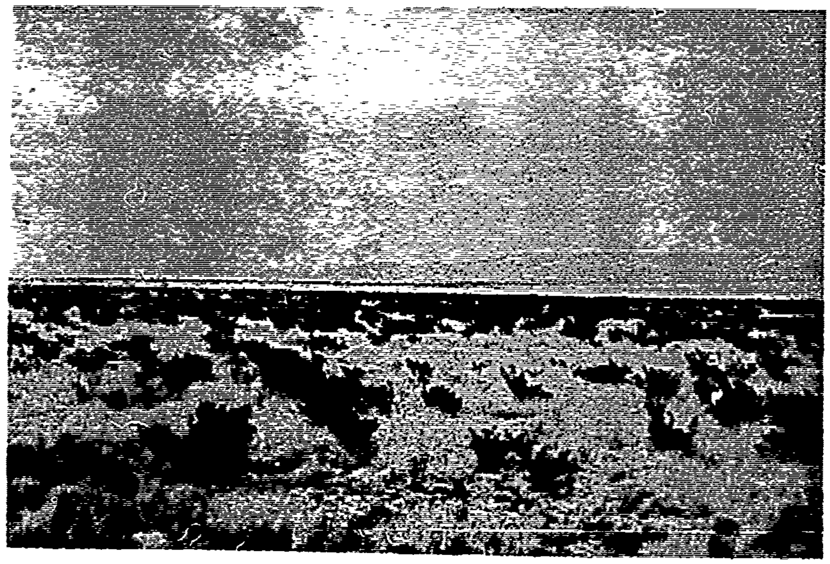


FIGURE 40. *Bouteloua eriopoda – Bouteloua gracilis – Larrea tridentata* Community (11) near Campbell Tank. Site 251.

Larrea tridentata was the common associate shrub, having ground cover ranging from 1 to 25 percent. Other shrub species infrequently observed with ground covers less than 5 percent were *Dalea formosa, Dyssodia acerosa, Opuntia* spp., *Xanthocephalum Sarothrae*, and *Yucca Torreyi.*

Soil textures in this community were mostly clay loam and loams with less than 20 percent gravel. Soil depth more than 40 cm was found on the flat-laying limestones of the Otero Mesa and on the butte at Campbell Tank. Soils of shallow depth (less than 15 cm) were found on the dissected hills and the upper alluvial fans. The Grass-*Larrea tridentata* community was comprised of the following three subcommunities:

1. *Bouteloua eriopoda – Larrea tridentata.* This community occurs on the Otero Mesa, on the butte at Campbell Tank, and on the dissected hills (figure 40). The dominant grass species was *Bouteloua eriopoda*, with ground cover ranging from 25 to 75 percent. Other grass species present were *B. curtipendula, B. gracilis*, and *B. hirsuta*, which had ground covers ranging from 1 to 25 percent.

2. *Bouteloua curtipendula – Larrea tridentata.* This subcommunity was dominated by *Bouteloua curtipendula.* with ground cover ranging from 6 to 50 percent and with *Larrea tridentata* as an associate shrub species. This community occurred on the upper alluvial fans coming from the Otero Mesa escarpment and on the dissected hills. Soils were clay loams with gravels, and the soil depth was less than 30 cm. *Muhlenbergia arenacea – Larrea tridentata* was also found on similar sites.

3. *Hilaria mutica – Scleropogon brevifolius – Larrea tridentata.* This subcommunity occurred on the dissected hills composed of interbedded limestones and shales. The *Hilaria mutica* and *Scleropogon brevifolius* grasses were predominantly on the gravelly clay soils developed on shale, and *Bouteloua curtipendula, B. eriopoda,* and *B. gracilis* were found on shallow clay loam on the bedded limestone unit.

Grass – *Flourensia cernua* (12). Grass species present in this community accounted for more than 50 percent of the ground cover. The dominant grass species were *Hilaria mutica* and *Scleropogon brevifolius,* which had ground cover values of 51 to 100 percent. *Muhlenbergia Porteri* was an important grass species, occurring infrequently as the understory beneath the shrub canopy. Grass species present with ground covers of 25 to 50 percent were *H. mutica, M. Porteri,* and *S. brevifolius,* with *M. arenacea* present with 1 to 5 percent ground cover (figure 41).

Flourensia cernua was the major shrub species with ground cover of 6 to 25 percent and a relative frequency of 100 percent. Other shrub species, *Atriplex canescens, Larrea tridentata,* and *Opuntia* spp., were less frequently observed, with ground covers less than 1 percent.

This community occurred in the drainageways in the alluvial fans, in washes, and in some playas in the Hueco Bolson and the Tularosa Basin (figure 41). Soils were clay or silty clay with little gravel and were usually greater than 30 cm deep. Observations made in some soil pits showed a caliche pan forming at the 30 to 60 cm depth, but this layer was not indurated.

FIGURE 41. *Scleropogon brevifolius* (S) – *Hilaria mutica* – *Flourensia cernua* (F) Community (12), with scattered *Opuntia* spp. (0) in a wash. (Landform unit D). Site 101.

Grass – *Acacia constricta* (13). The dominant grass species in this community were *Bouteloua curtipendula* and *B. eriopoda*, which had ground covers of 6 to 50 percent. *Acacia constricta* was the major shrub species, occurring in all quadrants and having a ground cover of 1 to 5 percent. Other shrubs less frequently present, but adding less than 1 percent to the ground cover, were *Dyssodia acerosa*, *Ephedra* sp., *Larrea tridentata*, *Opuntia* spp., *Parthenium incanum*, and *Xanthocephalum Sarothrae*.

This community occurred primarily on the dissected hills and escarpments along the buttes, the inselbergs, and the cuestas lying between the Otero Mesa escarpment and Route 54 (figure 34). Bedrock in these areas was bedded limestones and interbedded limestones and shales.

Soils were gravelly clay or gravelly clay loam with 15 to 30 percent gravel. Soil depth was very shallow to bedrock or the petrocalcic horizon, and less than 30 cm on the colluvium or soils developed on the shale.

Grass – *Artemisia filifolia* (14). Dominant grass species in this community were *Sporobolus cryptandrus* and *S. flexuosus*, with ground covers ranging from 6 to 75 percent. Although *S. contractus* was found in this community, its ground cover was generally less than 1 percent. Taxonomically, *S. cryptandrus* and *S. flexuosus* are very similar, which made field identification difficult when they were not flowering. Because both species commonly occurred in this community, the coverage and frequency values were grouped for convenience under *S. cryptandrus* in the phytosociological data (appendix D and figure 42).

Artemisia filifolia was the common shrub species in this community, having ground cover of 1 to 25 percent. *Atriplex canescens*, *Prosopis glandulosa*, *Xanthocephalum Sarothrae* and *Yucca elata* were frequently present, but their percent ground covers were less than 1 percent.

This community occurred almost exclusively on deep and very fine sands in the Hueco Bolson and Tularosa Basin. Soil textures were sandy loam or loamy sand, and the soil depth was greater than 60 cm.

FIGURE 42. *Sporobolus cryptandrus – Sporobolus flexuosus – Artemisia filifolia* Community (14) with *Yucca elata* (Y), and *Xanthocephalum Sarothrae* (X). (Landform unit C2). Site 173.

Grass – *Prosopis glanduloza* (15). This community was comprised of two subcommunities identified from the dominant grass. Grass cover in the two subcommunities ranged from 6 to 25 percent, with *Prosopis glandulosa* as the major associated shrub species.

1. *Bouteloua eriopoda – Prosopis glandulosa.*

The dominant grasses were *Bouteloua eriopoda* and *B. curtipendula*, which had ground covers ranging from 6 to 25 percent. Associated grass species with ground covers less than 5 percent were *B. gracilis* and *Aristida* spp. The major shrub species was *Prosopis glandulosa*, which had ground cover ranging from 1 to 5 percent. Other shrubs infrequently present were *Dalea formosa, Eurotia lanata, Xanthocephalum Sarothrae*, and *Yucca Torreyi*. These shrubs had ground covers less than 1 percent. The *Bouteloua eripopoda -- Prosopis glandulosa* community occurred on the Otero Mesa, the buttes, and the upper alluvial fans where soil depth was 10 to 40 cm. Soil texture was c' y loam with less than 20 percent gravel.

2. *Sporobolus cryptandrus – Sporobolus flexuosus – . ›sopis gland'ılosa.*

This variant was dominated by the grasses *Sporobolus cryptandrus* and *S. flexuous*, with *S. contractus* occurring as an associated grass species. *Prosopis glandulosa* was the major shrub, having a ground cover of 1 to 5 percent. Other shrubs less frequently observed were *Artemisia filifolia, Atriplex canescens, Xanthocephalum Sarothrae*, and *Yucca elata*. This community was found in dunal and flat-lying areas in the Hueco Bolson and the Tularosa Basin on the fine and very loamy sands and sandy loams. Soil depth was 30 to 80 cm in the interdunal areas (figure 43).

FIGURE 43. *Sporobolus cryptandrus – Sporobolus flexuosus – Prosopis glandulosa* (P) Community (15) with *Yucca elata* (Y), *Ephedra* sp. (E), and *Xanthocephalum Sarothrae* shrubs. (Landform Unit C1). Site 157.

Grass – *Parthenium incanum* (16). The Grass – *Parthenium incanum* community occurred on the dissected hills that form the Hueco Mountains and on the limestone outcrops on the Otero Mesa escarpment (figures 32 and 33). *P. incanum* was the major shrub species, having a ground cover from 6 to 25 percent. Associated shrubs occurring less frequently were *Dyssodia acerosa*, *Ephedra* sp., *Larrea tridentata*, *Viguiera stenoloba*, and *Xanthocephalum Sarothrae*, each having a ground cover ranging from 1 to 5 percent.

The community was divisible based upon the dominant grasses with which *P. incanum* occurred.

1. *Bouteloua curtipendula* – *Bouteloua eriopoda* – *Parthenium incanum*.

This plant community was dominated by the grasses *Bouteloua curtipendula* and *B. eriopoda*, which had ground covers ranging from 6 to 25 percent. Other associated grasses were *Aristida* sp., *Muhlenbergia setifolia*, and *Tridens muticus*, each having a ground cover less than 5 percent. Soils in this variant were shallow, gravelly loam, and gravelly silt loam over highly fractured bedded limestones (figure 44).

2. *Hilaria mutica* – *Lycurus phleoides* – *Parthenium incanum*.

Hilaria mutica and *Lycurus phleoides* occurred with *Parthenium incanum*, with *Acacia constricta* occasionally present. The grasses formed dense ground covers on clay soils, yet only accounted for 1 to 25 percent of the ground cover. This community occurred on the interbedded limestones and shales. Soils developed on the limestone were very shallow gravelly loams or were not present. Clay soils that were 15 to 30 cm in depth were found on the shale. This community was found at only several sites in the study area. Additional field work is necessary to describe the spatial distribution and species composition of this community.

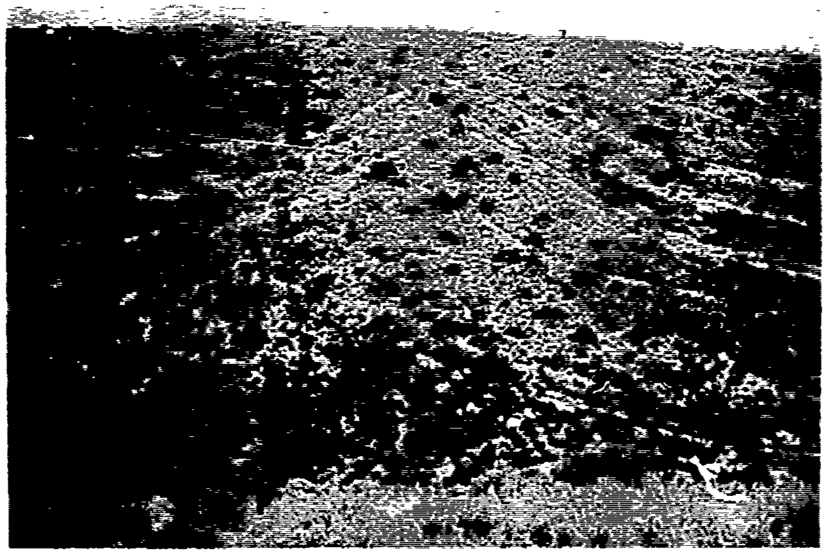


FIGURE 44. *Bouteloua curtipendula – Bouteloua uniflora – Parthenium incanum* (P) Community (16) with *Fouquieria splendens*, *Nolina* sp., and *Xanthocephalum Sarothrae*. (Landform unit A2). Site 291.

Shrublands. This was the major physiognomic group, comprising about 58 percent of the study area. The shrublands occurred primarily on the alluvial fans west of the Otero Mesa escarpment; on the fans surrounding the Franklin, Organ, and Jarilla Mountains; and in the Hueco Bolson and Tularosa basin. Shrub-dominated areas had limited distribution on the Otero Mesa and near the mesa escarpment. The major shrub species were *Acacia constricta*, *Artemisia filifolia*, *Flourensia cernua*, *Larrea tridentata*, *Parthenium incanum*, and *Prosopis glandulosa*. Shrubs were found on most soils and landform units in the study area; however, some shrub species were more frequently associated with specific soil and landform conditions. Grasses often formed the understory in some shrub communities. Along the major drainageways and on the flood plain terraces, *Chilopsis linearis*, *Fallugia paradoxa*, and *Thelesperma longipes* formed dense stands, but they were rarely observed in the upland areas.

Larrea tridentata (20). *Larrea tridentata* was the dominant plant species in this community, comprising 6 to 25 percent of the ground cover. Shrubs infrequently present with ground covers of 1 to 5 percent were *Dalea formosa* and *Xanthocephalum Sarothrae*. The shrubs present with ground covers less than 1 percent were *Opuntia* spp. and *Prosopis glandulosa*. Grasses were infrequently present, and their ground covers were less than 1 percent. *Aristida* sp. and *Tridens muticus*, both of which were of short stature, were the rarely present grass species (figure 45).

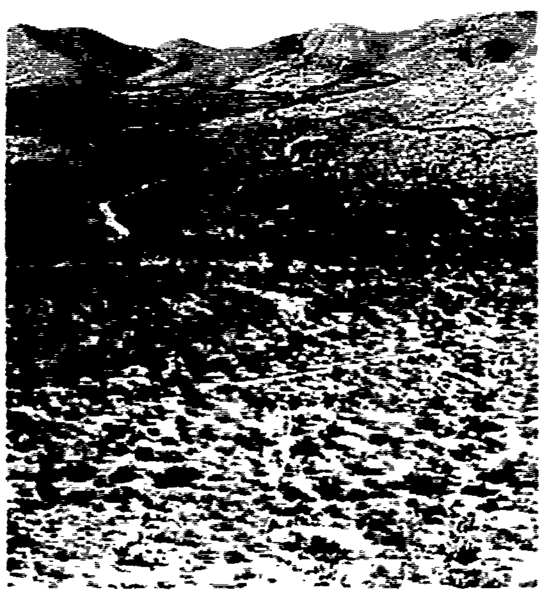


FIGURE 45. *Larrea tridentata* Community (20) on upper alluvial fans (B1). Site 212. The Jarilla Mountains (Landform A3) are on the horizon.

This community was found primarily on the alluvial fans and on some areas in the western and southern portion of the basins (figure 32). Soils on the alluvial fans were gravelly sandy clay loams and gravelly clay loams, and they were 15 to 30 cm deep to the petrocalcic horizon or bedrock. In the basin areas, the soil textures were sandy loam and sandy clay loam, and they were more than 30 cm deep. This shrub community was found on a wide range of soil textural conditions; on sandy loam soils in the south and western side of the study area near Chapparell, Texas, and Newman, New Mexico, sites 62 and 63 (figure 32); on gravelly clay loam soils on the lower alluvial fans, sites 2 and 72 (figure 32); and on shallow gravelly clay loam soils on the upper alluvial fans. The community was most often observed on the upper alluvial fans, B1 and B2, and on the intermediate alluvial fans, B3, which were covered with gravel particles that ranged from 2.5 to 5.0 cm in diameter.

Larrea tridentata - Grass (21). *Larrea tridentata* was the dominant shrub species in this community, having a ground cover ranging from 6 to 25 percent. Other shrubs infrequently present with ground covers less than 5 percent were *Opuntia* spp., *Parthenium incanum,* and *Xanthocepahlum Sarothrae.* Grasses were present with ground covers ranging from 1 to 25 percent. This community may be subdivided by the associated grass species.

1. *Larrea tridentata - Sporobolus Wrightii.*

This community occurred on the upper alluvial fans (B1, B2) on sandy clay loam and clay loam soils containing less than 20 percent gravels. Soil depth was variable, ranging from 30 to 90 cm. *Tridens muticus* infrequently occurred as an associate grass species where the soils were shallow and contained more gravel.

2. *Larrea tridentata - Muhlenbergia Porteri.*

This community occurred in the lower alluvial fan units and in the washes. Soils were 30 to 60 cm in depth and were gravelly clay loam in texture. The grass species occurring in this community were *Hilaria mutica, Muhlenbergia Porteri,* and *Scleropogon brevifolius. M. Porteri* often formed dense clumps beneath individual *Larrea tridentata* shrubs.

Larrea tridentata – *Parthenium incanum* – Grass (22). This plant community is similar to the *Larrea tridentata* – Grass community (20), except for the presence of the shorter, hemispherical shrub, *Parthenium incanum*, as a co-dominant or associate shrub species. The ground cover for *L. tridentata* varied from 6 to 25 percent and for *P. incanum*, from 1 to 25 percent. The shorter *Xanthocephalum Sarothrae* shrubs were frequently present with ground cover of 1 to 25 percent. Other associated shrub species infrequently present, with ground covers less than 1 percent, were *Acacia constricta, Flourensia cernua, Prosopis glandulosa, Rhus microphylla,* and *Yucca elata* (figure 46).

The grasses present in this community were *Bouteloua curtipendula, B. eriopoda, Muhlenbergia Porteri, Sporobolus cryptandrus, S. Wrightii, Trichachne californica,* and *Tridens muticus.* These grass species had ground covers ranging from 1 to 25 percent.

This community was found primarily on the dissected hills (A2) and on the higher and midlevel alluvial fans (B1 and B3). Soil textures were gravelly clay loam or gravelly sandy clay loam, and the soil depth was about 30 cm.

FIGURE 46. *Larrea tridentata* (L) – *Parthenium incanum* (P) – Grass Community (22) with *Xanthocephalum Sarothrae* on the alluvial fan (B1). Sites 196 and 197.

Larrea tridentata -- Prosopis glandulosa (23). This community was comprised of the co-dominant species *Larrea tridentata* and *Prosopis glandulosa*, which had ground covers ranging from 6 to25 percent. Other shrubs infrequently present in the community were *Flourensia cernua, Xanthocephalum Sarothrae*, and *Yucca elata*, with ground covers less than 5 percent. The ground cover of *X. Sarothrae* often equaled that of *L. tridentata* and *P. glandulosa*, but the taller *L. tridentata* and *P glandulosa* shrubs dominated the community.

Grass species were infrequently present, but were conspicuously absent at those sites where *X. Sarothrae* was most prevalent. *Muhlenbergia Porteri, Sporobolus cryptandrus, S flexuosus*, and *Tridens muticus* were the most common grass species.

This community was encountered primarily on the middle and lower alluvial fans, B3 and B4, and the sand-covered fan unit, B5, on the eastern and western sides of the study area between the *Larrea tridentata* communities (20 and 21) on the alluvial fans and the *Prosopis glandulosa -- Xanthocephalum Sarothrae -- Atriplex canescens* -- Grass community (50) of the basin areas (figure 47).

FIGURE 47. *Larrea tridentata* (L) – *Prosopis glandulosa* – *Muhlenbergia Porteri* (M) Community (23) on the lower alluvial fans (B3). Sites 41 and 42.

The associated grass species were indicative of the differences in landform and soil conditions. The grass species on the upper and middle elevation alluvial fans were *M. Porteri*, which formed a dense growth beneath the shrub canopies, and *T. muticus*. *P. glandulosa* was found in or immediately adjacent to the threads of the small drainageways on these fan units, and *L. tridentata* was found on both the interfluvial and fluvial areas. Soils were gravelly sandy clay loam, sandy clay loam, and clay loams with soil depth greater than 15 cm.

The community was also encountered in the basin areas on sandy clay loam and sandy loam soils that were greater than 45 cm deep. In these areas, the major grasses were *S. cryptandrus* and *S. flexuosus*, which reflected the sandy nature of these soils.

Larrea tridentata – Flourensia cernua – Grass (25). *Larrea tridentata* and *Flourensia cernua*, the dominant shrub species in this community, had ground covers ranging from 6 to 25 percent. *F. cernua* was often a subdominant shrub species at some sites with ground cover of 1 to 5 percent. Other shrub species infrequently present with ground cover values less than 5 percent were *Parthenium incanum*, *Prosopis glandulosa*, and *Xanthocephalum Sarothrae* (figure 48).

FIGURE 48. *Larrea tridentata – Flourensia cernua* – Grass community (25) on the drainageways and the lowest slopes of Landform B4 (Foreground). On the hillsides, a *Larrea tridentata – Parthenium incanum* community (22) is present.

The grass cover was variable, ranging from 6 to 50 percent, occurring frequently only as an understory beneath *L. tridentata* and *F. cernua* shrubs. The grass species found were *Bouteloua curtipendula, Hilaria mutica, Muhlenbergia arenacea, M. Porteri, Scleropogon brevifolius,* and *Tridens muticus.* Grass species on the clay and clay loam soils, 15 to 30 cm deep, on the lower fans and washes were *H. mutica, M. Porteri,* and *S. brevifolius. B. curtipendula* and *T. muticus* were present on the shallower gravelly sandy loam and gravelly sandy clay loam soils.

The community occurred primarily on the lower alluvial fans, B3 and B4, and in the washes. It was found on upper alluvial fans, but only with limited distribution. The community may be a transition between the *Larrea tridentata* communities (20 and 21) that occurred on areas of slightly higher relief on the lower alluvial fans and the *Flourensia cernua* – Grass community (30) found on heavier textured soils in the washes and drainage-ways of the lower alluvial fan units.

Acacia constricta – **Grass (30).** *Acacia constricta* was the dominant shrub in this community, with ground cover ranging from 6 to 25 percent. Actual vegetative cover was less than this value because of the very porous shrub canopy and the small leaf size of the shrub. Even so, the physiognomic aspect of this community was provided by the 1.0- to 1.5-meter tall *A. constricta* shrubs. *Parthenium incanum* was a subdominant shrub species, frequently present with ground cover of 1 to 5 percent. *Dalea formosa, Ephedra* sp., and *Xanthocephalum Sarothrae* occurred less frequently and had ground cover values less than 5 percent. Other shrubs infrequently observed, having ground covers less than 1 percent, were *Berberis trifoliolata, Dyssodia acerosa, Flourensia cernua, Larrea tridentata, Opuntia* spp., and *Yucca elata* (figure 49).

Grass species present were *Bouteloua curtipendula, B. eriopoda, B. uniflora, Hilaria mutica,* and *Scleropogon brevifolius* with ground covers ranging from 1 to 25 percent. The grass species composition and ground cover values varied between the sample sites with regard to soil/geologic conditions. *B. curtipendula* and *Sporobolus Wrightii* were frequently found on the bedded limestones of Landform A2. Areas comprised of interbedded limestones and shales, also in Landform A2, had *H. mutica* and *Scleropogon brevifolius* on the clay soils, and *B. curtipendula, B. eriopoda,* and *B. hirsuta* were on the shallow gravelly clay loam soils on the limestones.

Soils were primarily gravelly sandy clay loam, gravelly clay loam, gravelly clay, and clay, and they varied between 15 and 45 cm in depth. This community was found on the dissected hills landform unit (A2), primarily on the eastern side of the study area (figures 33 and 34).

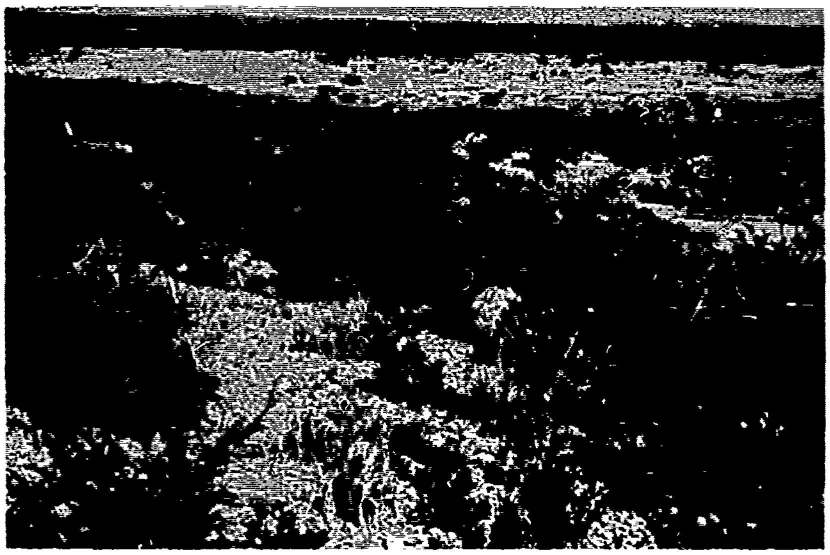


FIGURE 49. *Acacia constricta* – Grass community (30) with *Parthenium incanum* on Landform unit A2. Site 164 (Foreground). *Scleropogon brevifolius* – *Hilaria mutica* Grassland (12) in the outlined area (wash).

Acacia constricta – *Larrea tridentata* (31). *Acacia constricta*, the dominant shrub species, had ground cover ranging from 6 to 25 percent. *Larrea tridentata*, the major associate shrub species, had a ground cover ranging from 1 to 25 percent (figure 50). Other shrub species observed less frequently were *Dyssodia acerosa*, *Ephedra* sp., *Flourensia cernua*, *Opuntia* spp., *Parthenium incanum*, and *Xanthocephalum Sarothrae*, each of which had ground cover values less than 5 percent.

The grass species present were *Bouteloua curtipendula*, *B. eriopoda*, *Sporobolus cryptandrus*, *S. Wrightii*. and *Tridens muticus* on the shallow soils and fractured limestones (landform A2). *Hilaria mutica* and *Scleropogon brevifolius* were found on the clay soils developed on the shale layers of the interbedded limestone and shale series (landform A2).

Soil textures were gravelly clay, gravelly clay loam, or clay with gravels. Soils were often shallow to bedrock, and fractured limestones were often exposed on the surface.

FIGURE 50. *Acacia constricta* (A) – *Larrea tridentata* (L) community (31) with *Yucca baccata* (Y) on the upper alluvial fan (B1). Site 5. Hueco Mountains can be seen in the background (Landform unit A2).

The distribution of this community was on the inselbergs and dissected hills (landform A2) and on some upper alluvial fans (site 4) on the eastern side of the study area (figures 33 and 34). The species composition, with the exception of *L. tridentata* shrubs, was very similar to the *Acacia constricta* – Grass community (30). Additional study is needed to evaluate further the importance of *L. tridentata* as an adventive in the *Acacia constricta* – Grass community.

Flourensia cernua – Grass (40). *Flourensia cernua* was the dominant shrub species, having ground cover ranging from 6 to 25 percent. Shrubs less frequently observed were *Atriplex canescens* (1 to 5 percent), *Opuntia* spp. (less than 1 percent), and *Prosopis glandulosa* (less than 1 percent).

Two grass species, *Scleropogon brevifolius* and *Hilaria mutica*, were the major associate species, with ground covers ranging from 6 to 25 percent (figure 51). Soils were primarily silty clay, clay loam, or clay, with some gravelly loam. Soil depth was more than 30 cm.

FIGURE 51. *Flourensia cernua* (F) – *Scleropogon brevifolius* (S) – *Hilaria mutica* (H) community (40) with *Rhus microphylla* (R) on the wash, Landform unit D Sites 95 and 96.

This community was commonly found on the lower alluvial fans and in the washes on both sides of the basin. It was occasionally found on the Otero Mesa and in the drainageways where surficial water could readily collect or be channeled, such as those leading to and surrounding the cattle watering tanks. In undisturbed areas, the grasses formed a dense cover that imparted a dark, almost black, smooth photo tone on the aerial photographs (site 16, figure 7).

Flourensia cernua – Larrea tridentata – Grass (41). *Flourensia cernua* and *Larrea tridentata* were the co-dominant shrub species providing the physiognomic aspect to this community. Their ground covers were variable, but most ranged from 6 to 25 percent, with higher ground cover values from 26 to 50 percent observed at some sites. Other shrub species infrequently present (20 to 40 percent absolute frequency) were *Artemisia filifolia, Atriplex canescens, Ephedra* sp., *Prosopis glandulosa, Xanthocephalum Sarothrae,* and *Yucca elata,* each of which had ground cover values less than 5 percent. Within this community, *L. tridentata* appeared to favor slight increases in elevation, which may correspond to older alluvial surfaces. *F. cernua* and the grasses favored lower areas where surficial water was most likely to flow or collect.

Grasses were common, usually as the understory, and had ground cover values ranging from 6 to 75 percent. The frequently observed grass species were *Hilaria mutica*, *Muhlenbergia arenacea*, and *M. Porteri*, although species composition varied between sites.

The soils were clay, clay loam, or sandy clay in the surface horizons with increased gravel content in the lower profile. Soil depth was 30 to 90 cm, but a petrocalcic horizon was occasionally encountered within 30 cm of the surface.

This community, shown in figure 52, was found on the lower elevation alluvial fans and in the washes (B4 and D), primarily on the eastern side of the study area (figures 33 and 34). The community occurred on small areas on the Otero Mesa and in the swale at the foot of the alluvial fans on the eastern side of the Franklin and Organ Mountains (figure 32).

FIGURE 52. *Flourensia cernua* – *Larrea tridentata* community (41) with *Prosopis glandulosa* on the lower alluvial fans (B4). Sites 160 and 162. The grasses are *Hilaria mutica* and *Scleropogon brevifolius*

Prosopis glandulosa – Xanthocephalum Sarothrae – Atriplex canescens – Grass (50). This community was rather homogeneous in its species composition, consisting of very few shrub species and grasses (figure 53). *Prosopis glandulosa* was the dominant shrub species, with ground cover ranging from 6 to 25 percent. The associate, less frequently observed shrub species (40 to 60 percent absolute frequency), were *Atriplex canescens, Ephedra* sp., *Xanthocephalum Sarothrae*, and *Yucca elata*, each with ground covers less than 5 percent.

Grasses were frequently present, although the percent ground cover was highly variable, ranging from negligible values at half of the sample quadrants to 25 percent at the other sites. Grass species present were *Muhlenbergia setifolia, Sporobolus cryptandrus, S. flexuosus,* and *S. contractus.* In the small shallow depressions and in the playas of the Hueco Bolson and the Tularosa Basin, *Aristida* sp., *Hilaria mutica, H. Porteri,* and *Panicum obtusum* formed stands with ground covers greater than 50 percent. *P. glandulosa* formed the shrub overstory. Annual herbaceous species were found seasonally, often with substantial ground covers.

The soil texture of the 0 to 15 cm soil horizon was loamy sand, sandy loam, or sandy clay loam. Soil depth was more than 30 cm, although soils less than 15 cm were found locally in the deflation areas between the coppice dunes (site 52).

FIGURE 53. *Prosopis glandulosa* (P) – *Xanthocephalum Sarothrae* (X) – *Atriplex canescens* (A) – *Sporobolus* spp. community (50) on the Coppice Dunes (C1) in the Tularosa Basin. Site 66.

This community was found primarily in the Hueco Bolson and the Tularosa Basin and on those alluvial fans covered with aeolian sand (B5). The two landform units were similar in that numerous coppice dunes had formed around the *P. glandulosa* shrubs. Because *P. glandulosa* can develop adventitious roots from buried stems, the species has an advantage over other shrubs that lack this ability when both become buried by aeolian sand. The deflation and deposition of aeolian sand around shrubs within this community and the rate of shrub growth are related causative factors resulting in the paucity of associate shrub species in this community.

This community rarely occurred on alluvial fans not covered by substantial amounts of aeolian sand. Field observations and laboratory photo analysis showed that *P. glandulosa* was often an associate shrub in other communities, such as in plant communities 23 and 41.

Prosopis glandulosa – Larrea tridentata (51). *Prosopis glandulosa* was the dominant shrub, having percent ground cover from 6 to 25 percent and occasionally 26 to 50 percent. *Larrea tridentata* and *Xanthocephalum Sarothrae* were associate shrubs with ground covers ranging from 1 to 5 percent. Other shrubs infrequently present were *Parthenium incanum* and *Yucca elata*, with ground covers ranging from 1 to 5 percent. Grass species were present, with ground covers less than 5 percent, although occasionally values ranged from 6 to 25 percent.

This community was present on both sides of the basin where the lower alluvial fans and the washes abutt the coppice dune areas (figure 33). The distribution of the community indicates this is probably a transition community between the *Prosopis glandulosa* communities in the basin areas and the *Larrea tridentata* communities on the lower alluvial fans. This is indicated by both the landform units upon which the community is located and the soil texture data available for the community.

The soil data from this community were extremely limited. However, based on knowledge of soil conditions on similar landforms, one can predict that the soils are probably gravelly loams on the upper parts of the alluvial fans, becoming more sandy on the lower parts of the fans at the fringes of the basin area.

Prosopis glandulosa – Artemisia filifolia (52). *Prosopis glandulosa* was the dominant shrub, with ground cover values ranging from 6 to 25 percent. The major associate shrub species were *Artemisia filifolia* and *Xanthocephalum Sarothrae*, with ground covers of 1 to 5 percent. *Atriplex canescens* was commonly present, but its ground cover was less than 1 percent.

Analyses of soils from site 106 showed that the texture of the surface was sandy loam, grading to sandy clay loam with depth. However, additional soil sampling in this community is needed so the range of soil conditions can be more fully described. Other samples from this landform unit suggest that soils in this community are loamy sand or sandy loam. Soil depth was 60 cm or more and contained less than 3 percent gravel.

This community was found only on the eastern side of the study area, entirely within the basin. It occurred in areas having coppice dunes less than 1 to 2 meters tall, and in flat, smooth areas in the basin. The community occupied areas between the *Prosopis glandulosa* community (50) on the coppice dunes and the *Artemisia filifolia* community (60) on deep undulating sands and on the shallow sand deposits with slightly undulating surfaces. This position suggests that this community is a transition one between the *Artemisia filifolia* and *Prosopis glandulosa* communities.

Artemisia filifolia – Grass (60). *Artemisia filifolia*, the dominant shrub in this community, had ground cover ranging from 6 to 25 percent. Other shrubs infrequently present were *Atriplex canescens*, *Ephedra* sp., *Xanthocephalum Sarothrae*, and *Yucca elata*, which had ground covers less than 5 percent. *Dalea scoparia* was a co-dominant species in some areas where its ground cover values ranged from 6 to 25 percent.

Grass species were commonly present and had ground covers of 6 to 25 percent. The major grass species were *Sporobolus contractus*, *S. flexuosus*, and *S. cryptandrus* (figure 54).

Soils were sand, loamy sand, or sandy loam, and contained essentially no gravel-size particles. When gravel particles were present, they made up negligible percentages of the sample. Soil depth was more than 65 cm at most sites. A petrocalcic horizon was found at about 1.5 to 2 meters below the surface in the community near the Meyer Small Arms Range.

FIGURE 54. *Artemisia filifolia – Sporobolus cryptandrus – Sporobolus flexuosus* community (60) with *Dalea scoparia* and *Ephedra* sp. on the deep sands (Landform unit C2). Sites 30 and 31.

The community occurred primarily on the eastern side of the Hueco Bolson and the Tularosa Basin, paralleling the Otero Mesa escarpment in a discontinuous band. In some instances, the *Artemisia filifolia* – Grass community occurred on limited areas of the Otero Mesa; near Godfrey Tank; and along Route 62, 33 km east of El Paso, Texas. In both these instances, the soil texture was sandy, and the soil depth was greater than 100 cm.

At site 270, the *Artemisia filifolia* – Grass community was found on an inselberg in the dissected hills landform unit (A2), portions of which had been covered by more than 1 meter of aeolian sand. Several individuals of *Juniperus monosperma* and *Quercus undulata* were found in the community. These tree species, although commonly found at higher elevations, were well established here as individuals 3 to 5 meters in height.

In the basin areas, this community was divisible on the basis of the type of surface on which it was located; (1) deep sand and highly undulating surfaces, or (2) moderate to deep sand on slightly undulating surfaces. The largest contiguous area of the *Artemisia filifolia* – Grass community occupied the deep sands on highly undulating surfaces, extending from Route 506 to Borrego Tank (figure 33). This area contained the deepest sand deposits encountered in the study area and was the only area in which large blowouts were found. The blowouts were often 3 to 4 meters in diameter and 1 to 3 meters deep (sites 243, 244, and 245). In areas around the Orogrande firing range and Wilde Tanks (sites 30 and 31), *Dalea scoparia,* a large, dense hemispherical shrub, was co-dominant with ground cover ranging from 6 to 25 percent. Along the margin of this community, microrelief changes of 1 to 2 meters were encountered between highly undulating sand surfaces of the barchan dunes and the adjoining alluvial fans and washes.

The area of moderate-to-deep sand on slightly undulating surfaces was found near McGregor Range Camp and Meyer Small Arms Range, and north of Route 506 to Sacramento City. In these areas, *Prosopis glandulosa* shrubs occurred within this community. The *Artemisia filifolia* community (60) gradually changed into an *Artemisia filifolia -- Prosopis glandulosa* community (61) or *Prosopis glandulosa -- Artemisia filifolia* (52) community.

Artemisia filifolia -- Prosopis glandulosa (61). *Artemisia filifolia* was the dominant shrub species in this community, having ground cover ranging from 6 to 25 percent. *Prosopis glandulosa* occurred as the major associate species with ground cover ranging from 1 to 5 percent. Other shrubs occurring in the community, but with ground covers less than 1 percent, were *Ephedra* sp., *Opuntia* spp., *Xanthocephalum Sarothrae,* and *Yucca elata.*

Grasses were commonly found throughout the community, with *Sporobolus cryptandrus* and *S. flexuosus* as the major species.

Soils were sandy loams with no gravel particles. Insufficient soil data were available to adequately describe the range of soil textures in the community, but soil data from the same landform indicate that soil textures were sands, sandy loams, and loamy sands, and soil depth was 75 cm or more.

This community was found in the basin areas and was associated with other communities dominated by *P. glandulosa* or *A. filifolia.* This community was not encountered frequently. Judging from the soil conditions of this and other *P. glandulosa* and *A. filifolia* dominated communities found in the basins, one can predict that this community is probably a transition stage in the evolution of either *P. glandulosa* or *A. filifolia* dominated communities.

Forestlands (70). The forested and treed areas had very limited distributions. Stands of small trees were associated with some cattle watering tanks (ponds), i.e. Campbell Tank, Borrego Tank, Flat Tank, and Mack Tank, and the protected draws on the Otero Mesa escarpment, i.e. Owl Tank Canyon. Tree species forming these small stands were *Acacia* sp., *Celtis* sp., *Populus* sp., *Prosopis glandulosa*, *Tamarix ramosissima*, and *Ulmus* sp., with *Juniperus monosperma* and *Quercus undulata* limited to the isolated draws. Although *P. glandulosa* occurred as a small tree along the borders of some cattle watering tanks, i.e Hay Meadow Tank and Lake Tank, its normal stature in the study area was a short-to-medium-height shrub. In some major drainageways extending into the Hueco Bolson and Tularosa Basin from the Otero Mesa escarpment, *Chilopsis chiliensis* formed dense stands of tall shrubs and small trees.

For all practical purposes, the only forested areas found that satisfied minimum mapping criteria were those at the higher elevations approaching the Sacramento Mountains in the northestern portion of the study area (figure 34) and the Organ Mountains (figure 33). In these areas, *Juniperus monosperma*, *Pinus edulis*, and *Quercus undulata* were the major tree species. Associate shrub species were *Agave* sp., *Cercocarpus montanus*, *Chrysothamnus* sp., *Nolina* sp., and *Xanthocephalum Sarothrae*. Soils in these areas were very shallow to bedrock on the middle and upper slopes, and they were gravelly silty clay and silty clay with some gravel particles on colluvial material on lower slopes. Figures 55 and 56 illustrate the *Juniperus monosperma – Quercus undulata* community near Culp Draw on the northeast edge of the study area, and in the Organ Mountains on the western side of the study area, respectively.

FIGURE 55. *Juniperus monosperma* (J) – *Quercus undulata* community (70) with *Chrysothamnus* (C) sp. *Cercocarpus montanus* and *Bouteloua curtipendula* (Landform unit A2) near Culp Draw.

FIGURE 56. *Juniperus monosperma – Quercus undulata* community (70) with *Cercocarpus montanus* in the Organ Mountains (Landform unit A3).

Other (90). This mapping unit included those sample quadrants in which the percent bare ground was greater than 75 percent, and where vegetative ground cover was less than 25 percent, but the percent ground cover of any particular species was not greater than 5 percent.

Soils were generally gravelly silt loam formed on upper alluvial fan units. The gravel fraction was about 20 percent of the sample.

PLANT COMMUNITY AND LANDFORM RELATIONSHIPS. Data were obtained by simultaneous sampling of the vegetation and landform maps. The maps for each photomosaic were superimposed one on the other, and by using the point sampling technique, data that describes combinations of plant communities and landforms were collected at 6,033 sample points. The frequency of each relationship is presented as a percent of the total sample in table 7. The sum of each row equals the percent of the study area in which a particular plant community occurred. The sum of each column equals the percent of the study area classified as a particular landform. The values shown are relative percentages of the study area because the mosaics were not geographically rectified.

The percentage value given at the intersection of a row and a column is the percentage of the study area occupied by a particular plant community/landform association. Only about one-half of the 350 potential associations between the 25 land cover mapping units and the 14 landform mapping units were encountered; 30 of these had a frequency of 0.5 percent or greater, and 15 had a frequency of 1.0 percent or greater. The plant community/landform relationships with the highest frequencies were the *Prosopis glandulosa* – *Xanthocephalum Sarothrae* – *Atriplex canescens* – Grass (50) community and the light-toned, speckled sand dunes (C1), which accounted for about 26 percent of the study area; the grassland community (10) and the mesa (A1), 13.3 percent; and the Grass – *Parthenium incanum* (16) community and the highly dissected hills (A2), 8.5 percent.

The frequency table shows that the occurrence of the plant communities is not independent of landform units. By using the chi-square test to evaluate plant community/landform frequency data, one can show that the plant communities were not independent of the landform unit at the 95 percent level of confidence, with 107 degrees of freedom:

$$\text{Chi-square} = \frac{(f_2 - f_1)^2}{f_1} \tag{8}$$

where f_2 equals the observed frequency and f_1 equals the expected frequency (17.2). The number of degrees of freedom were determined as

$$DF = [(R - 1) - (C - 1)] - n \tag{9}$$

TABLE 7. Frequencies of Plant Community and Landform Relationships (Percent Basis)

PCN	Landform Unit A1	A2	A3	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	D	Total
10	13.3	2.2	.7	.4	.1	.7	.1	.3	.7	.4	.3	1.0	.2	.8	21.2
11	.2	.1	0.0	.0	.1	0.0	.1	.0	0.0	.1	0.0	0.0	.1	.0	.7
12	.0	.1	0.0	.2	.1	.0	.4	0.0	0.0	.0	0.0	0.0	.1	.3	1.2
13	0.0	.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.0
14	0.0	0.0	0.0	0.0	0.0	0.0	.2	.0	0.0	.3	.0	.0	.1	0.0	.6
15	0.0	0.0	0.0	.0	0.0	0.0	.0	.1	0.0	1.3	.4	.2	.1	0.0	2.1
16	2.0	8.5	.1	.4	.1	.0	.0	.0	0.0	0.0	0.0	0.0	0.0	.2	11.3
20	.0	1.2	.3	4.6	.1	2.1	.5	.3	0.0	.1	.0	0.0	.1	.2	9.5
21	.0	.4	.1	2.8	.2	.4	.3	.0	0.0	.2	0.0	0.0	0.0	.1	4.5
22	0.0	.2	.3	.1	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.6
23	0.0	.0	0.0	.6	.1	1.2	.3	.8	0.0	.7	.1	.0	.1	.1	4.0
25	.0	.2	0.0	.7	.1	.1	.4	.2	0.0	.0	0.0	0.0	.4	.2	2.3
30	.0	.9	0.0	.2	.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
31	.0	.6	.0	.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.7
40	0.0	0.0	0.0	0.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.0
41	0.0	.3	0.0	.2	.1	.3	.9	.0	0.0	0.0	.0	0.0	0.0	.3	2.1
50	0.0	.1	0.0	.1	0.0	.1	0.0	.9	0.0	25.8	.3	.2	.1	0.0	27.6
51	0.0	0.0	0.0	.1	0.0	.1	.0	.3	0.0	.1	.1	.0	.0	0.0	.7
52	0.0	.0	0.0	0.0	0.0	.0	.0	.0	0.0	.4	.1	.1	.0	0.0	.6
60	.2	.0	0.0	.1	0.0	.0	.3	.2	.0	.2	1.0	.6	.2	.0	2.8
61	0.0	.0	0.0	0.0	0.0	.0	.0	.0	0.0	.4	.1	.1	0.0	0.0	.6
70	0.0	1.3	.7	.1	.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
90	0.0	.0	.1	.0	0.0	0.0	0.0	.0	0.0	.0	0.0	0.0	0.0	0.0	.1
91	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.1	0.0	0.0	0.0	0.0	.1
92	0.0	0.0	0.0	0.0	.1	1.6	.0	0.0	0.0	.0	.1	.1	.1	0.0	2.0
Total	15.7	16.1	2.3	10.7	1.3	6.8	3.5	3.1	.7	30.1	2.5	2.3	1.6	2.2	98.7

PCN = Plant Community Number

.0 = Frequencies < 0.1%
0.0 = No Observations

◯ = Frequency ⩾ 1.0 percent

where R is the number of rows, C the number of columns, and n is the sum of observed frequencies less than 5.[37]

Apportioning the frequency data of each plant community with regard to landform was made on a 100 percent basis. This shows the likelihood of encountering a plant community, given a specific landform unit (table 8). The plant community/landform associations were grouped into one of three arbitrary classes: (1) those with frequencies of 20 percent or more, which were the major associations; (2) those with 10 to 20 percent frequency, which were minor associations; and (3) those with less than 10 percent, which were the least important associations.

Figure 57 illustrates the association of the major plant communities, those occurring on more than 20 percent of a landform unit, and the minor plant communities, those occurring on 10 to 20 percent of a landform unit. The length of the line segments represents the relative percentage of the study area occupied by each landform unit.

Mountain/Hills (A1, A2, A3) Plant Communities. The plant communities associated with the mesa landform (A1) were primarily the grassland communities 10, 10A, and 10B, of which the *Bouteloua eriopoda* – *Bouteloua curtipendula* grassland (10A) was the most common and had its greatest occurrence on this landform unit. The Grass – *Parthenium incanum* community (16) was found where soils were shallow or bedrock was exposed and also found along the mesa escarpment. The Grass – *Larrea tridentata* community (11) occurred primarily in this landform unit, but its frequency was very low.

[37] J.E. Freund, *Modern Elementary Statistics*, 4th Ed. Englewood Cliffs, NJ; Prentice-Hall, Inc., 1973, p 532.

TABLE 8. Frequency of Plant Community and Landform Relationships as a Percentage of the Landform Unit.

PCN	A1	A2	A3	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	D
10	83.8	13.4	28.9	3.5	8.1	10.2	1.8	9.2	4.4	1.3	10.3	42.0	15.0	36.8
11	1.5	.6	0.0	.4	5.4	0.0	1.8	.9	0.0	.4	0.0	0.0	4.2	.4
12	.2	.4	0.0	2.2	12.6	.6	11.1	0.0	0.0	0.0	0.0	0.0	4.2	14.0
13	0.0	.1	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	6.0	.3	0.0	1.0	1.6	.6	5.7	0.0
15	0.0	0.0	0.0	.1	0.0	0.0	1.1	3.3	0.0	4.2	15.5	9.5	6.4	0.0
16	12.4	53.0	2.6	4.0	5.4	.1	.3	.9	0.0	0.0	0.0	0.0	0.0	7.1
20	.2	7.2	14.9	42.5	8.1	31.1	13.7	9.8	0.0	.4	1.6	0.0	4.2	10.3
21	.2	2.4	4.8	26.0	14.3	6.6	8.2	.3	0.0	.6	0.0	0.0	0.0	5.8
22	0.0	1.1	12.2	.7	0.0	0.0	.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	.2	0.0	6.0	7.2	18.1	8.2	24.0	0.0	2.4	2.4	1.2	6.4	2.6
25	.2	1.0	0.0	6.5	7.2	2.1	12.3	6.8	0.0	.1	0.0	0.0	27.0	8.1
30	.2	5.4	0.0	1.8	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	.1	3.9	1.3	.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.0	1.8	0.0	2.2	5.4	4.6	24.8	1.1	0.0	0.0	.4	0.0	0.0	14.0
50	0.0	.4	0.0	.7	0.0	.9	0.0	27.2	0.0	85.4	11.1	7.8	7.8	0.0
51	0.0	0.0	0.0	1.2	0.0	1.6	.3	10.1	0.0	.5	4.3	1.6	.7	0.0
52	0.0	.1	0.0	0.0	0.0	.1	.3	1.1	0.0	1.3	5.2	4.7	.7	0.0
60	1.1	.2	0.0	.7	0.0	.1	7.4	4.7	5.6	.7	40.4	23.9	11.3	.4
61	0.0	.1	0.0	0.0	0.0	.1	.8	.3	0.0	1.2	5.2	5.8	0.0	0.0
70	0.0	8.0	31.5	.6	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	0.0	.2	4.0	.1	0.0	0.0	0.0	.3	0.0	0.0	0.0	0.0	0.0	0.0
91	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.2	0.0	0.0	0.0	0.0
92	0.0	0.0	0.0	0.0	12.6	23.3	.3	0.0	0.0	0.0	2.4	3.3	6.4	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

PCN = Plant Community Number

.0 = Frequencies < 0.1%

0.0 = No Observations

○ = Frequency ≥ 1.0 percent

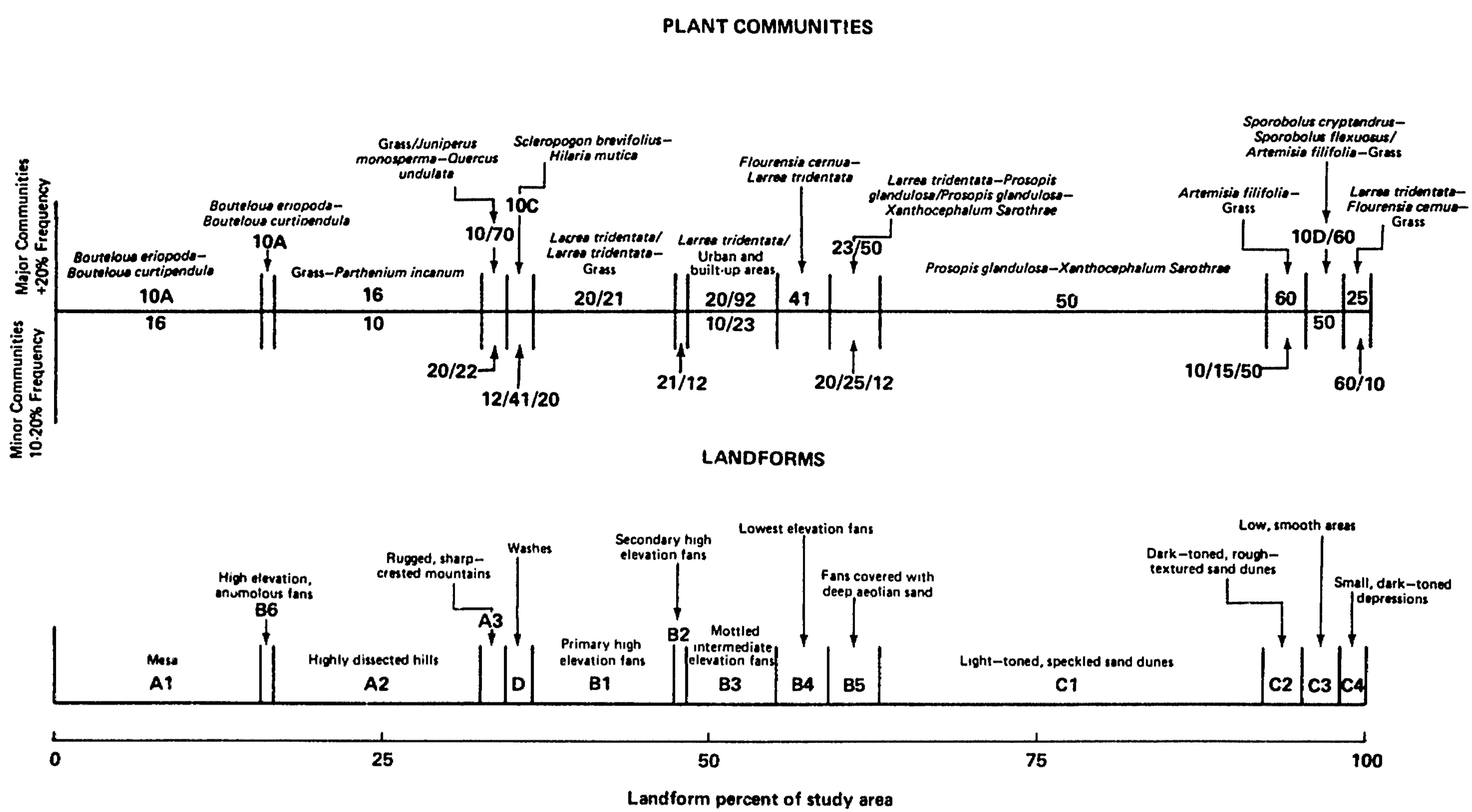


FIGURE 57. Plant community associations with specific landforms. The width of each landform unit is proportional to its relative percentage of the study area. The frequencies of major and minor plant communities reflect the relative percentage that that community occurs on the landform. For example, the *Bouteloua* grassland (10A) occurs on more than 20% of landform A1 and is the major plant community.

The most common plant community associated with the highly dissected hills (A2) was the Grass – *Parthenium incanum* (16) community, which occurred primarily on this landform type. Grassland communities were found on a limited basis, with *Bouteloua curtipendula – Bouteloua uniflora* (10B) the most common grassland on the A2 landform. Grass – *Acacia constricta, Acacia constricta* – Grass, and *Acacia constricta – Larrea tridentata* – Grass communities (13, 30, and 31) were found almost exclusively on this landform unit between the Otero Mesa and Route 54, although this was not apparent from data in table 8. The *Juniperus monosperma – Quercus undulata* community (70) was found on landform A2, along the southern flank on the Sacramento Mountains.

Two communities were common on the rugged, sharp-crested mountain landform (A3), the *Bouteloua curtipendula – Bouteloua uniflora* grassland (10B) and the *Juniperus monosperma – Quercus undulata* community (70). The latter community was found in the Organ Mountains. The *Larrea tridentata – Parthenium incanum* – Grass community (22) was a minor community associated with landform A3. About half of its distribution was found on landform A3.

Alluvial Fan (B1, B2, B3, B4, B5, B6) Plant Communities. The plant communities found on the alluvial fans were those in which *Larrea tridentata* was either the dominant or major associate species. On the upper alluvial fans, B1 and B2, *Larrea tridentata* and *Larrea tridentata* – Grass communities (20 and 21) were the major plant communities. This was also the landform unit on which they most commonly occurred. Other shrub and grass communities were more common on the middle and lower elevation alluvial fans, B3 and B4, where a mixture of the Grassland, *Flourensia cernua,* and *Prosopis glandulosa* communities (10, 41, and 50) and *L. tridentata* dominated communities (20, 23, and 25) were found. The communities associated with the lower alluvial fans were *Larrea tridentata,* (20); *Flourensia cernua – Larrea tridentata* – Grass, (41); *Larrea tridentata – Prosopis glandulosa – Xanthocephalum Sarothrae,* (23); *Larrea tridentata – Flourensia cernua* – Grass, (25); Grass – *Flourensia cernua – Larrea tridentata,* (12); and the Grassland community (10), primarily the *Scleropogon brevifolius – Hilaria mutica* community (10C). The *Flourensia cernua* – Grass community (40) was found only on the lowest alluvial fan, B4, covering large areas, although in regard to the total study area its frequency was quite low.

The major plant communities found on the sand-covered alluvial fans (B5) were those dominated by either *L. tridentata* or *P. glandulosa,* i.e. primarily either the *Larrea tridentata – Prosopis glandulosa – Xanthocephalum Sarothrae* (23), or *Prosopis glandulosa – Larrea tridentata* (51) community. The association of these communities on landform B5 accounted for about 20 and 35 percent, respectively, of their total coverage in the study area. The occurrence of *P. glandulosa* dominated communities on the alluvial fans indicates changes in soil conditions on the fan brought about by deposition of aeolian sand. Where the amount of sand was substantial, the shrubs incapable of tolerating partial or complete burial, i.e. *L. tridentata,* are eliminated, then replaced by species capable of either adventitious growth or rapid establishment on the active fan areas. *P. glandulosa* appears to be replacing *L. tridentata,* particularly on areas subjected to aeolian sand deposition. The *Larrea tridentata – Prosopis glandulosa – Xanthocephalum Sarothrae* (23) community occupies sites where aeolian deposition is active on the fan and occupies sites between the upper alluvial fan (B1) communities dominated by *L. tridentata* (20 and 21) and the *Prosopis glandulosa – Xanthocephalum Sarothrae – Atriplex canescens* – Grass community (50) of the basin areas.

The alluvial fans on the Otero Mesa (B6) were covered almost entirely with grassland communities, *Bouteloua eriopoda – Bouteloua curtipendula* (10A) in particular. Two isolated areas of the *Artemisia filifolia* – Grass community (60) were also found.

Basin Area (C1, C2, C3, C4) Plant Communities. Four landform units were identified in the basin areas: (1) light-toned, speckled sand dunes (coppice dunes, C1); (2) dark-toned, rough-textured sand dunes (C2); (3) low, smooth areas (C3); and (4) small, dark-toned depressions (C4).

The most prevalent plant community in the basin area was clearly the *Prosopis glandulosa – Xanthocephalum Sarothrae – Atriplex canescens* – Grass (50) community, which occupied about 85 percent of the C1 landform. Other communities dominated by either *Artemisia filifolia* or the *Sporobolus* spp. grasses were found on limited areas of the C1 sand dunes, but their occurrence was clearly overshadowed by the presence of the *Prosopis glandulosa* community. Plant communities occurring on the C1 landform and which accounted for more than 40 percent of their coverage within the study area were *Prosopis glandulosa – Xanthocephalum Sarothrae – Atriplex canescens* – Grass (50), Grass – *Prosopis glandulosa* (15), Grass – *Artemisia filifolia* (14), *Prosopis glandulosa – Artemisia filifolia* (52), and *Artemisia filifolia – Prosopis glandulosa* (61) communities.

The major plant community associated with the large, dark-toned sand dunes (C2) was the *Artemisia filifolia* – Grass community (60). The minor plant communities were the *Sporobolus cryptandrus – Sporobolus flexuosus* (10D), Grass – *Prosopis glandulosa* (15), and *Prosopis glandulosa – Xanthocephalum Sarothrae – Artiplex canescens* – Grass (50) communities.

The plant communities in the low, smooth areas on the basins (C3) were mostly *Sporobolus cryptandrus* – *Sporobolus flexuosus* grasslands (10D) and the *Artemisia filifolia* – Grass (60) community. *Sporobolus cryptandrus* and *S. flexuosus* were the dominant grass species in both communities.

The major plant community in the small depression area (C4) was *Larrea tridentata* – *Flourensia cernua* – Grass (25). The minor communities associated with this landform were the *Sporobolus cryptandrus* – *Sporobolus flexuosus* grassland (10D), and the *Artemisia filifolia* – Grass (60) communities. In the almost circular depressions, or playas, grass communities dominated by *Hilaria mutica* and *Muhlenbergia Porteri* were found.

Wash (D) Plant Communities. Along the major drainageways, several plant communities were encountered, all of which had species common to each other but which differed in dominant species. The major plant community was the grassland community (10) dominated by *Scleropogon brevifolius* and *Hilaria mutica.* The *Sporobolus giganteus* (10E) community was less frequently found. Minor plant communities associated with this landform were Grass – *Flourensia cernua* (12), *Flourensia cernua* – *Larrea tridentata* – Grass (41), and *Larrea tridentata* (20).

DISCUSSION

The major landform and plant communities identified in this study were comparable with those identified by Wyatt[38] and by Kenmatsu and Pigott.[39] Associations of plant communities with specific landform units and soil conditions were also identified in these prior studies, but greater diversity was found among the plant communities and landforms in this study than was previously described. The phytosociological data of this study (appendixes A, B, and F) show a greater diversity among the shrub-dominated communities than previous studies, particularly those communities dominated by *Larrea tridentata* or *Prosopis glandulosa.*

The greatest divergence between this and previous studies, however, is in the grassland community (10), analogous to the Grama-Dropseed-Vine Mesquite association of Kenmatsu and Pigott.[40] The present study found greater habitat diversity within the grassland mapping unit and within the phytosociological data of the grassland community than had been described previously, although the diversity in the grassland could not be depicted on the 1:50,000 scale photography and was mapped as a single grassland community (10). The five grassland communities were identified and described from phytosociological and field data. The grouping of all grasslands into a single community did not recognize the narrow habitat requirements of the various grass species within the mapping unit. The terrain data associated with the grassland mapping unit further substantiated this conclusion, and five grassland sub-communities, each dominated by one or two grass species, were recognized.

All plant species in the study area can be separated into four groups that are defined by soil conditions and landform types (table 9). The first group of plant species are those species found on sandy-textured soils in the basin areas. The species most commonly associated with these soils and the C1 and C2 landform units were *Prosopis glandulosa, Artemisia filifolia, Xanthocephalum Sarothrae, Atriplex canescens, Sporobolus flexuosus, S. cryptandrus, S. contractus* and *Yucca elata.* Except for *P. glandulosa, Y. elata,* and *X Sarothrae,* these

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[38]J.T. Wyatt, "Ecological Analysis McGregor Range (New Mexico), Fort Bliss, Texas" in US Army Environmental Hygiene Agency, *Environmental Assessment of McGregor Range (New Mexico) Fort Bliss, Texas.* March-July 1975.

[39]R.D. Kenmatsu and J.D. Pigott, *A Cultural Resources Inventory and Assessment of McGregor Guided Missile Range, Otero County,* New Mexico, Part III. Botanical and Geological Studies. Tex. Archelogical Survey Research Report No. 65:III, University of Texas, Austin, TX.

[40]Ibid.

TABLE 9. Summary of Plant Community, Landform, Edaphic Associations

Plant Community	Soil Depth	Soil Texture	Landform Unit
1.			
Sporobolus cryptandrus – *Sporobolus flexuosus* (10D)	> 50 cm	sa, lm, sacllm	C1, C2
Sporobolus flexuosus – *Sporobolus cryptandrus* – *Artemisia filifolia* (14)	> 60 cm	lmsa, salm	C1
Artemisia filifolia – *Sporobolus cryptandrus* – *Sporobolus flexuosus* (60)	> 65 cm	sa, salm, lmsa	C2, C3
Artemisia filifolia – *Prosopis glandulosa* – *Sporobolus cryptandrus* (61)	> 75 cm	sa, salm, lmsa	C1, C3
Prosopis glandulosa – *Xanthocephalum Sarothrae* – *Atriplex canescens* – *Sporobolus* spp. (50)	> 30 cm	lmsa, salm, sacllm	C1
Prosopis glandulosa – *Artemisia filifolia* – Grass (52)	> 60 cm	lmsa, salm	C1, C2
Sporobolus cryptandrus – *Sporobolus flexuosus* – *Prosopis glandulosa* (15)	30–80 cm	lmsa, salm	C1, C2
2.			
Grass – *Acacia constricta* (13)	< 30 cm	cl	A2
Acacia constricta – Grass (30)	15–45 cm	sacllm, cllm, cl	A2

TABLE 9. Continued

Plant Community	Soil Depth	Soil Texture	Landform Unit
Acacia constricta – Larrea tridentata – Grass (31)	< 15 cm	cl, cllm, cl	A1
Bouteloua curtipendula – Bouteloua eriopoda– Parthenium incanum (16)	< 15 cm	lm, silm	A1, A2
Bouteloua curtipendula – Bouteloua uniflora (10B)	< 15 cm	cllm	A2
Bouteloua curtipendula – Larrea tridentata (11)	< 15 cm	cllm, lm	A1, B1
Hilaria mutica – Scleropogon brevifolius – Larrea tridentata (11)	< 30 cm	cllm	A2
Larrea tridentata – Parthenium incanum (22)	< 30 cm	cllm, sacllm	A2, A3, B1
Larrea tridentata – Flourensia cernua – Grass (25)	15–30 cm < 15 cm	cl, cllm salm, sacllm	B4, D B1
3.			
Scleropogon brevifolius – Hilaria mutica (10C)	> 30 cm	sicl, cl, cllm	A2, B4, D
Scleropogon brevifolius – Hilaria mutica – Flourensia cernua – Larrea tridentata (12)	> 30 cm	cl, sicllm	B4, D

TABLE 9. Continued

Plant Community	Soil Depth	Soil Texture	Landform Unit
Flourensia cernua – *Scleropogon brevifolius* – *Hilaria mutica* (40)	>30 cm	sicl, cllm, cl	B4
Flourensia cernua – *Larrea tridentata* – Grass (41)	30–90 cm	cl, cllm, sacl	B4
Sporobolus giganteus (10E)	>100 cm	cllm	D
Larrea tridentata – *Muhlenbergia Porteri* (21)	30–60 cm	cllm	B4, D
Bouteloua eriopoda – *Bouteloua curtipendula* (10A)	>30 cm	cl, cllm, sacl	A1
Larrea tridentata – *Sporobolus Wrightii* (21)	30–90 cm	sacllm, cllm	B1, B2
Larrea tridentata – *Prosopis glandulosa* – Grass (23)	15–30 cm 45 cm	sacllm, cllm sacllm, salm	B3, B5 C1, B5
4.			
Bouteloua curtipendula – *Prosopis glandulosa* (15)	10–40 cm	cllm	B1
Prosopis glandulosa – *Larrea tridentata* – Grass (51)	—	—	B5
Bouteloua curtipendula – *Larrea tridentata* (11)	15–30 cm	cl	A2
Bouteloua eriopoda – *Larrea tridentata* (11)	40 cm	cllm, lm	A1
Larrea tridentata (20)	15–30 cm	sacllm, cllm	B1, B3

species were rarely found on non-sandy soils. Most of these species have deep root systems that extend to a depth of several meters, but which probably do not extend to the water table in the basin areas reported to be 38 meters (125 feet) by Meinzer[41] and Cliett.[42] *P. glandulosa*, reportedly a phreatophyte in parts of Arizona,[43] is probably not a phreatophyte in the Tularosa Basin and the Hueco Bolson because of the great depth to ground water. Trenches dug in the coppice dunes show *P. glandulosa* produces adventitious roots from buried branches. The formation of adventitious roots from buried stems generally begins about 15 cm below the dune surface; a dense root system was evident in the two-meter profile dug in several coppice dunes.

The soil texture in the basin areas suggests that only very drought-tolerant species should occupy these soils; however, the soil volume from which the plants can absorb water is substantial. The deposition of sand in the shrub canopy increases the soil volume from which the plant could obtain soil moisture. This larger volume of soil can have a greater potential plant-available water reservoir than some shallow loam and silty clay soils on other landform units. The species on the sand dunes are probably moderately drought tolerant, but are not as drought tolerant as those species found on shallower soils or exposed bedrock, i.e. *Acacia constricta* or *Larrea tridentata.*

Soil textures in the basin areas were sandy loams, sandy clay loams, silty clay loams, loamy sands, and sand. Soil depth varied from less than 30 cm in the interdunal areas to more than 2 meters from the tops of the coppice dunes. In the very deep sands (C2), the soil depth was greater than 2 meters with no indurate horizon within this depth. Although most of the soils hold small amounts of water (less than 5 percent plant-available water), the potential soil water–reservoir is large because of the soil depth. Observations made in several pits determined that the petrocalcic horizon had many fractures and channels in which water and plant roots could penetrate to deeper horizons (figure 27).

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[41]O.E. Meinzer and R.F. Hare, "Geology and Water Resources of Tularosa Basin, New Mexico." *USGS Water Supply Paper* 343, 1915. pp 11-55 and 176-207.

[42]T.Cliett, "Groundwater occurrence of the El Paso Areas and its related geology" *New Mexico Geol. Soc. Guidebook* 20; 1969. pp 209-214.

[43]O.E. Meinzer, "Plants as indicators of Ground Water." *Washington Acad. Sci. Journ.* 16(2):533-564, 1926.

A second group of plant species was associated with the upper alluvial fans and the upland areas underlain by limestone bedrock (the highly dissected hills and parts of the mesa landforms). Soils found on the upper alluvial fans and on the highly dissected hills were less than 15 cm deep to bedrock or to the petrocalcic horizon. Soils were clay, clay loam, loam, and gravelly loam, and many soils contained substantial amounts of gravel. The mesa soils were less than 30 cm deep and were gravelly clay loam in texture.

The plant species occurring in these areas were the grasses *Bouteloua curtipendula, Muhlenbergia setifolia, Sporobolus Wrightii,* and *Tridens muticus.* The shrub species were *Acacia constricta, Agave* sp., *Dyssodia acerosa, Ephedra* sp., *Fouquieria splendens, Koeberlina spinosa, Larrea tridentata, Nolina* sp., *Parthenium incanum, Yucca baccata,* and *Y. Torreyi. Hilaria mutica* and *Scleropogon brevifolius* occurred in these plant communities on clay soils 15 to 30 cm deep. *Bouteloua eriopoda* and *L. tridentata* occurred on the mesa, where silty clay loam and loam-textured soils were greater than 30 cm in depth. Soils in these areas were capable of holding substantial amounts of plant-available water per unit volume of soil; however, soil depth was the factor limiting the total soil-water reservoir.

A third group of plant species was associated with the lower alluvial fans, the depressions in the basins, and the washes. The soils were mostly clay loam, silty clay loam, clay, and sandy clay, which were more than 30 cm deep. The plant species commonly found on these soils were the grasses *Hilaria mutica, Muhlenbergia Porteri, Scleropogon brevifolius,* and *Sporobolus giganteus* and the shrubs *Flourensia cernua* and *Larrea tridentata.* These species and the communities they formed occupied low lying areas that received water from adjacent areas, which suggested these species were the least drought tolerant. Their presences primarily on deep soils that could hold substantial plant-available water substantiates this observation. *H. mutica* and *Scleropogon brevifolius* were found in the *Acacia constricta* -- Grass community (30) on the highly dissected interbedded limestones and shales. *H. mutica* was found only on the clay soils developed on the shale beds that could receive surface runoff from the upper slopes.

The fourth group of plant species was associated with the intermediate and sand-covered alluvial fans, parts of the mesa, the dissected hills, and the upper alluvial fans. The soils in these areas were 15 to 30 cm deep and were clay loam, clay, sandy clay, and sandy clay loam. Grass species occurring on these soils were *Bouteloua curtipendula, B. eriopoda, Muhlenbergia* sp., and *Sporobolus Wrightii.* The shrub species were *Larrea tridentata* and *Prosopis glandulosa.*

Certain environmental factors, which affected the plant species and plant community distribution, varied in intensity in the different landform units. In the basin area, the climatic factors were rather uniform throughout, although variations in precipitation and temperature have been reported (table 1). The edaphic (soil) factors were believed to be the major influences on the distribution of plant species.

The effects of soil texture, soil depth, soil moisture, depth to ground water, and soil salinity on the distribution of plant species in arid regions have been discussed by others.[44,45,46] Depth to ground water was probably an insignificant factor affecting plant distribution because the water table has been reported at depths in excess of 38 meters (125 feet), well below the anticipated root zone for most plant species in the area.[47,48] Perched water could be a local consideration, but for most of the study area, perched water was probably not as important as some other factor(s). Soil salinity was not a significant factor because salt concentration in the soil was too low to effect the distribution of plant species (appendix C). Soil salinity could be a factor affecting plant distribution in a few small areas located below the Otero Mesa escarpment where gypsum was present at or near the soil surface.

The soil depth, soil texture, and soil moisture relationships are probably the more important factors affecting plant distribution in this study area. The potential soil-water reservoir within the root zone probably has the greatest effect upon species distribution because of its influence on seedling establishment and growth, which are the critical stages for plants invading new sites, and in plant growth in general. Two edaphic factors directly affecting the soil-water reservoir are the soil texture, which in turn affects the soil moisture retention characteristics, and the soil depth. The soil textures in the study area were highly correlated with the potential water retained by a soil at the field capacity (0.33 bar potential) and the wilting point (15 bars potential). Soil analysis revealed that the potential water held in a soil varied inversely with the percent sand and directly with the percent clay (figures 9 and 10).

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[44] T.H. Kearney, L.J. Briggs, H.L. Shantz, W.J.W. McLane, and R.L. Piemeisel. "Indicator Significance of Vegetation in Tooele Valley Utah." *Journ. Agri. Res.* Vol. 1:365-417, 1914.

[45] D.H. Gates, L.A. Stoddart and C.W. Cook. "Soil as a Factor Influencing Plant Distribution on Salt Deserts of Utah." *Ecological Monographs*, V.26, 1956. pp 155-175.

[46] F.A. Branson, R.F. Miller and I.S. McQueen, "Moisture Relationships in Twelve Northern Desert Shrub Communities near Grand Junction, Colorado." *Ecology* 57:1104-1124, 1976.

[47] O.E. Meinzer and R.F. Hare, "Geology and Water Resources of Tularosa Basin, New Mexico." *USGS Water Supply Paper* 343,1915. pp 11-55 and 176-207.

[48] T.Cliett, "Groundwater Occurrence of the El Paso Areas and its Related Geology." *New Mexico Geol. Soc. Guidebook* 20:209-214, 1969.

Soil depth directly affects the soil-water reservoir, primarily as a dimensional parameter affecting soil volume. For two soils of the same texture, one shallow and the other deep, the shallow soil would hold the lesser amount of plant-available water because of its smaller soil volume. In this area, drought conditions can exist for most of the year, and soil moisture in the root zone can be at the wilting point for substantial periods. Herbal found that insufficient available soil moisture from April through June limited the growing season.[49] During the growing season, July through September, and when normal precipitation occurred, readily available soil moisture, held at less than 5 bars potential, was present in the upper 25 cm of the soil profile about half the time. The number of days when soil water was available during the drought years was about half that found for years of normal precipitation. Climatic data for the study area show the total evaporation can be 10 times greater than the precipitation (table 2). This ratio was also reported by Campbell for the coppice dune area near the Jornada Range, New Mexico.[50] This indicates biological and physical factors are affecting the plant-soil-water relationships and are influencing the distribution of the plant species in the study area. The potential evaporation/precipitation ratio and the plant-available water held in the soil indicates that soil and atmospheric drought conditions can exist for some time during the growing season. Factors affecting the recharge of the soil-water reservoir and plant drought tolerance and drought evasive measures now become important considerations explaining the plant distribution.

The frequency and depth that recharge of the soil-water-holding capacity could occur depends on the initial soil moisture status, soil texture, soil depth, soil infiltration and percolation characteristics, and the frequency, amount, and intensity of precipitation. Water falling on a soil surface usually infiltrates the surface and percolates downwards, thereby recharging the soil-water reservoir. During intense precipitation events, surface runoff can carry away much of the precipitation when the rate of precipitation exceeds the infiltration and percolation rates, which can happen frequently during the late summer and early fall in this area. Surface runoff in some parts of the dune area can be a frequent event in view of the number of small drainageways observed on the ground and on the 1:50,000 scale photography. These areas apparently have a petrocalcic horizon near the surface in the interdunal areas. Because sandy-textured soils hold less water per unit soil volume than do the silty clay- and clay-textured soils (figures 9 and 10), a given amount of water can fill the

[49]C.H. Herbal, "Fertilizing Tabosa Grass on Floodplains in the Semidesert Grassland." *J. Range Management.* 16:133-138. 1963.

[50]R.S. Campbell, "Vegetative Succession in the Prosopis Dunes of Southern New Mexico." *Ecology* 54.1094-398. 1929.

soil-water-holding capacity of a sandy soil to greater depth in the soil profile than for the finer textured soils. Plants growing on these sandy-textured soils could readily deplete the soil–water reservoir because the amount of plant-available water is rather low; generally less than 8 percent. To obtain water from the soil, plant species must develop extensive root systems that provide access to a large soil volume from which they could acquire plant-available water for their biological processes. In the sandy soils in the basin areas, the dominant shrub species *Prosopis glandulosa, Artemisia filifolia, Dalea scoparia, Xanthocephalum Sarothrae,* and *Atriplex canescens* have deep root systems (> 3 meters). The grasses, also found in this areas, *Sporobolus flexuosus, S. cryptandrus,* and *S. contractus,* have moderately deep root systems (about 3 meters), but most of the grass root systems are found near to the soil surface (within 0.5 meter).

Plant species growing on soils with large soil-water reservoirs, such as silty clay and clay soils, may not require as extensive a root system as those species growing on sandy soils, since the fine-textured soils have a greater water-holding capacity per unit volume of soil. Dominant shrub species on these soils were *Larrea tridentata* and *Flourensia cernua* and the major grass species were *Hilaria mutica, Muhlenbergia Porteri, M. arenacea, Sporobolus Wrightii,* and *Tridens muticus.* Although the silty and clayey soils hold more plant-available water, 10 to 15 percent, they require more water to recharge them once they have "dried out." The recharge can be slow or negligible, particularly during intense rainfall events of short duration. If water does not percolate below the active zone of surface evaporation, the soil water would be lost through surface evaporation with little uptake by the plants.

The infiltration rate determines the amount of water entering the soil and percolating through the profile. During intense precipitation events, a substantial amount of precipitation falling on the fine-textured soils can become surface runoff, which takes away water that otherwise might have been held in the soil profile for plant uptake. Surface runoff from fine-textured soils on steep slopes, such as those found on A2, A3, and B1 landforms, would remove rainfall that would have recharged the soil-water reservoir to a considerable depth, but because the infiltration and percolation rates decrease as the soil surface becomes wet, only the upper centimeters may be wetted. Given enough time, the water falling on these sites could percolate through the soil profile and recharge the soil-water-holding capacity. The slower infiltration and percolation rates of the fine-textured soils in the lower alluvial fans (B3 and B4) and the playas (C4) are offset by the surface water received from higher elevations and slopes and by the greater length of time for the surface waters to infiltrate and percolate these soils on the less steep slopes (0 to 3 percent). Although the infiltration rate drops off as the surface horizon is wetted, water is held on the surface for a longer time, during which water can move into the soil and percolate to deeper levels.

Each of the 22 plant communities recognized in the study area were associated more frequently with one or more particular landform units than with others, as discussed above. This was interpreted as the species of a community being adjusted to the soil and soil-water conditions of the landform unit. Field and laboratory data show soil depth and textural conditions varied throughout the study area with landform conditions (table 4). Because of the effect of these two edaphic factors on the soil-water reservoir, it can be assumed that the potential soil-water-holding capacity also varied. Species occurring on certain soil conditions reflect these edaphic differences as well as the species drought tolerance and moisture requirements: the more drought-tolerant species would be expected on the more xeric sites, and the less drought-tolerant species, on soils with large soil-water reservoirs in the root zone, and on sites where water from other areas accumulated or flowed. For example, plant species such as *Acacia constricta, Fouquieria splendens, Opuntia* spp., and *Nolina* sp., were routinely found on the dissected, interbedded limestones where soils were very shallow or nonexistent. This was probably the most xeric site in the study area, since the amount of plant available water held in the soil was very small, although some water could be held in rock fractures.

Larrea tridentata, Parthenium incanum, Bouteloua curtipendula, Viguiera stenoloba, Sporobolus Wrightii, and *Muhlenbergia arenacea* were found on the dissected hills landform unit (A2) and the alluvial fans (B1, B3) where soil depth was generally 2 to 30 cm and soil textures were gravelly clay loam and gravelly loam. Soils on these sites had the potential to hold substantial amounts of water per unit volume; however, once the soil water was depleted, these soils probably remained droughty throughout the summer and fall growing season. The surface decimeter(s) may be wetted by precipitation during the growing season, August through October; but surface slope, soil infiltration and percolation rates, and high intensity precipitation would prevent full recharge of the soil-water reservoir during this period. Surface and subsurface soil horizons would be recharged during the late fall and winter months by less intense precipitation events.

Prosopis glandulosa, Flourensia cernua, Larrea tridentata, Atriplex canescens, Opuntia spp., *Rhus aromatica, R. microphylla, Muhlenbergia Porteri, Scleropogon brevifolius, Hilaria mutica,* and *Panicum obtusum* occurred on the lower alluvial fans (B3 and B4) on the deeper (30 to 75 cm) silty clay loam and clay loam soils that often times received surface runoff from upper slopes. *P. glandulosa* was observed encroaching onto the B3 alluvial fans on the eastern slopes of the Franklin Mountains, but only along the threads of the small drainageways. *L. tridentata,* the dominant species on this alluvial fan unit, occurred at slightly higher elevations (less than 0.3 meter) on coarse-textured, shallow soils that formed the interfluves. The occurrence of these two species on this landform unit and their occupation of dissimilar microhabitats illustrates their relative drought tolerances and water requirements. *L. tridentata* occurred on shallow soils that had low soil-water retention and *P. glandulosa* occurred on deeper soils or on sites that provided a greater potential for receiving substantial water. *P. glandulosa* and *L. tridentata* also occurred together in limited areas of the coppice dune region. *P. glandulosa,* the dominant species, occupied the coppice dunes that it had created and stabilized where soil depth could be 2 meters or more. *L. tridentata* occurred as a rare-to-infrequent species where soil depth to the petrocalcic horizon was generally less than 0.5 meter. The sites occupied by these two species were very similar to that of the B3 alluvial fan unit. *L. tridentata* occurred on the droughtier soils, and *P. glandulosa,* on soils having a greater soil–water reservoir, or on sites that could receive water from adjacent areas.

The presence of *L. tridentata* on the alluvial fans and in the coppice dunes on calcareous soils where the petrocalcic horizon was close to the soil surface illustrates the rather wide ecological amplitude of this shrub and its association with calcareous soils. Shreve and Mallery found *L. tridentata* on soils highly impregnated with calcareous materials, but it was only infrequently found or was absent from sites where caliche was absent. They observed that the vigor of *L. tridentata* shrubs was inversely related to the depth of the petrocalcic horizon.[51] Hallmark and Allen concluded from studies in western Texas and eastern New Mexico that the distribution of *L. tridentata* was affected by the gravel content and the depth of free calcium carbonate.[52] *L. tridentata* shrubs were found on calcareous soils that had significant amounts of gravel; whereas, noncalcareous soils low in gravel tend to be devoid of *L. tridentata* shrubs. These previous studies and the findings of this study support the association of *L. tridentata* with gravelly, calcareous soils. This association was most commonly observed on the alluvial fans, but occasionally was found in the coppice dune areas. *L. tridentata* was found on most soil conditions and landform units within the study area, which supports the view that this species has a rather wide ecological amplitude.[53]

[51]F. Shreve, "The Sandy Areas of the North American Desert." Year-Book of the Association of Pacific Coast Geographers, V. 4, 1938. pp 11-14.

[52]C.T. Hallmark and B.L. Allen, "The Distribution of Creosotebush in West Texas and Eastern New Mexico as Affected by selected soil properties." *Soil Sci.Amer. Proc* 39:120 , 1975.

[53]J.H. Burk and W.A. Dick-Peddie, "Comparative Production of *Larrea divaricata* Cav. on Three Geomorphic Surfaces in Southern New Mexico." *Ecology* 54:1094-1102, 1973.

Flourensia cernua was found on some upper alluvial fan units on very shallow soils. The species had its best development and growth, however, on the silty clay loam, loam, and sandy loam soils in the washes and on the B4 alluvial fans.

The extrapolation of the relationships identified in this study and described above to other areas is a matter for continued investigation. Observations made adjacent to the study area show that these relationships are applicable to other areas where these species occur. Problems may arise when extrapolating these relationships, in that ecotypical differentiation within a dominant species could change its tolerance limits and, hence, its landform and soil relationships, even when comparable landform units and soils conditions were encountered.

The plant community-plant species/landform unit-soil condition relationships developed here point out the significant influence of soil texture and soil moisture on plant community distribution. A plant community occurring on one specific landform unit might be found on a different landform unit if suitable soil texture and soil moisture conditions were present.

CONCLUSIONS

1. The identification of critical plant species and the identification and description of 22 plant communities from phytosociological data collected at 294 sample sites were readily accomplished using a computerized version of the Tabular Comparison Method.

2. The Tabular Comparison Method and analytical procedures were compatible with the aerial photography interpretation procedures for locating, sampling, and describing potential plant communities. The plant communities described from the phytosociological data were mappable on the 1:50,000 scale panchromatic aerial photography using the photo tones and textures associated with the plant communities.

3. The plant communities inferred from interpretation of photo tones and textures required ground truth data to identify between dominant and associated species.

4. The distribution of plant communities was found to be closely related to the soil and terrain conditions of the different landform units. The five major plant communities that covered 94 percent of the study area and associated with five landform units that accounted for 80 percent of the landforms in the study area were identified. The associations were:

   a. Mesa (A1) with the Grassland community (10A) *Bouteloua eriopoda – Bouteloua curtipendula.*

   b. The limestone and shale member of the highly dissected hills (A2) with the *Bouteloua curtipendula – Parthenium incanum* community (16).

   c. The upper and intermediate alluvial fans (B1, B2, B3) with the *Larrea tridentata* (20) and *Larrea tridentata* – Grass (21) communities.

   d. The speckled sand dunes (coppice dunes) (C1) with the *Prosopis glandulosa – Atriplex canescens – Xanthocephalum Sarothrae – Sporobolus* spp. community (50).

   e. The dark-toned sand dunes (C2) with the *Artemisia filifolia – Sporobolus* spp. community (60).

5. The 22 plant communities were commonly associated with certain soil conditions:

a. Sandy textured soils, more than 30 cm deep.

b. Clay, clay loam, loam, gravelly loam, and gravelly clay loam textured soils less than 5 cm deep.

c. Clay loam, clay, sandy clay, and sandy clay loam textured soils 15 to 30 cm deep.

d. Clay loam, silty clay loam, clay, and sandy clay textured soils more than 30 cm deep.

6. Soil moisture constants for the 0.33 and 15 bar potentials were inversely correlated with the percent sand of the soil samples and directly correlated with the percent clay of the soil samples.

7. The upper and lower limits of plant-available soil water, field capacity and wilting point, respectively, were related to the percent sand plus the percent clay of the soil samples by the following multiple regression equations that had multiple R coefficients of 0.96 and 0.93 respectively:

$$FC = 25.51 - (0.27 \cdot \text{sand}) + (0.10 \cdot \text{clay})$$
$$WP = 10.04 - (0.11 \cdot \text{sand}) + (0.11 \cdot \text{clay})$$

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APPENDIX A

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
1	4747-4	638368	1	137
2	4748-2	968470	1	75
3	4748-2	968470	1	75
4	4748-2	987445	1	101
5	4748-2	987445	1	103
6	4748-2	972410	1	103
7	4748-2	972410	1	103
8	4749-2	56993	3	313
9	4749-2	56993	3	313
10	4849-3	66991	3	313
11	4849-3	66991	3	313
12	4849-3	78975	3	313
13	4849-3	83976	3	313
14	4849-3	80978	3	313
15	4849-3	121995	3	293
16	4849-3	117993	3	293
17	4849-3	135971	3	293
18	4849-3	220003	3	274
19	4849-3	220003	3	274
20	4848-4	155955	3	293
21	4848-4	155956	3	293
22	4848-4	217941	3	272
23	4748-1	990835	3	12
24	4748-1	990825	3	12
25	4748-1	994828	3	12
26	4748-1	8835	3	12
27	4748-1	8835	3	12
28	4748-1	27835	3	12
29	4748-1	27835	3	12
30	4848-4	64898	3	295
31	4848-4	64898	3	295
32	4748-1	57905	3	295
33	4848-4	132927	3	311
34	4848-4	132927	3	295
35	4848-1	113916	3	295
36	4748-1	995794	3	12
37	4748-1	995794	3	12
38	4748-1	15788	3	12
39	4748-1	23792	3	12
40	4748-1	23792	3	12
41	4848-4	67820	3	12
42	4848-4	67820	3	12
43	4848-4	67820	3	12
44	4848-4	83827	3	309
45	4848-4	125802	3	309
46	4848-4	123802	3	309
47	4848-4	139795	3	297
48	4848-4	139795	3	297
49	4848-4	161751	3	299
50	4848-4	152736	3	299

APPENDIX A. (continued)

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
51	4748-3	780501	2	89
52	4748-3	780501	2	89
53	4748-3	775520	2	89
54	4748-3	774518	2	89
55	4748-3	718562	2	89
56	4748-3	709578	2	89
57	4748-3	709578	2	89
58	4748-3	687504	1	80
59	4748-3	688505	1	80
60	4748-3	685501	1	80
61	4748-3	685501	1	80
62	4748-3	683502	1	80
63	4748-3	683502	1	80
64	4748-3	682503	1	80
65	4748-3	683502	1	80
66	4748-3	657558	1	40
67	4748-3	660577	1	40
68	4748-3	660577	1	23
69	4748-3	658631	1	23
70	4647-1	550280	1	140
71	4647-1	550280	1	140
72	4748-2	4553	3	18
73	4748-2	2553	3	18
74	4748-2	956594	3	23
75	4748-2	967597	3	23
76	4748-2	984556	3	21
77	4748-2	984556	3	21
78	4748-3	815491	1	78
79	4748-3	815491	1	78
80	4748-3	818491	1	78
81	4748-3	818491	1	78
82	4748-2	15527	3	18
83	4748-1	907719	3	60
84	4748-1	908718	3	60
85	4747-1	10262	1	130
86	4747-1	48294	1	130
87	4848-3	73582	3	305
88	4848-3	73582	3	305
89	4848-3	92645	3	306
90	4848-3	92646	3	306
91	4848-3	148593	3	301
92	4848-3	148593	3	301
93	4748-2	28626	3	315
94	4748-2	28627	3	315
95	4848-4	66780	3	309
96	4848-4	66780	3	309
97	4848-4	120730	3	309
98	4848-4	135706	3	309
99	4848-4	135706	3	309
100	4848-4	131709	3	309

APPENDIX A. (continued)

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
101	4848-4	131709	3	309
102	4747-1	824403	1	101
103	4747-1	824403	1	101
104	4747-1	863407	1	101
105	4747-1	863407	1	101
106	4748-2	857437	1	101
107	4748-2	856588	1	101
108	4748-2	853552	1	42
109	4748-2	853552	1	42
110	4747-4	614327	1	138
111	4648-2	555590	1	38
112	4648-2	530606	1	25
113	4648-2	523642	1	26
114	4648-2	502645	1	26
115	4749-1	2964	3	30
116	4749-1	975972	3	30
117	4749-2	962975	3	30
118	4749-2	952925	3	30
119	4748-2	911646	3	58
120	4747-2	46835	3	11
121	4849-3	68155	3	316
122	4848-4	149849	3	310
123	4748-1	35798	3	13
124	4849-3	259098	3	275
125	4848-4	164812	3	310
126	4849-3	276068	3	275
127	4748-2	25463	1	73
128	4849-3	265011	3	273
129	4849-3	219025	3	373
130	4748-2	683503	1	40
131	4748-2	682503	1	40
132	4748-2	683503	1	40
133	4748-2	687503	1	40
134	4748-2	687503	1	40
135	4748-2	687503	1	40
136	4648-2	558567	2	154
137	4648-2	559567	2	154
138	4648-2	559567	2	154
139	4648-2	559567	2	154
140	4648-2	525524	2	154
141	4648-2	525524	2	154
142	4849-3	233008	3	274
143	4849-3	233008	3	274
144	4849-3	194995	3	274
145	4849-3	194995	3	274
146	4849-3	160982	3	293
147	4849-3	160982	3	293
148	4849-3	160982	3	293
149	4849-3	134972	3	293
150	4849-3	134972	3	293

APPENDIX A. (continued)

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
151	4849-3	134972	3	293
152	4849-3	87977	3	312
153	4849-3	87977	3	312
154	4848-3	100615	3	303
155	4748-3	777502	1	78
156	4748-3	777502	1	78
157	4748-3	788507	1	78
158	4748-3	788507	1	78
159	4748-1	994827	3	27
160	4848-4	98762	3	309
161	4848-4	98762	3	309
162	4848-4	98762	3	309
163	4848-4	129721	3	299
164	4848-4	129721	3	299
165	4848-4	115726	3	299
166	4748-4	584432	1	97
167	4748-3	582433	1	97
168	4748-3	613445	1	97
169	4748-3	613445	1	97
170	4748-3	613445	1	97
171	4748-3	763417	1	99
172	4748-3	763417	1	99
173	4748-2	862437	1	75
174	4748-2	864545	1	42
175	4748-3	604431	1	138
176	4748-3	604431	1	138
177	4848-4	102852	3	310
178	4848-4	119854	3	310
179	4848-4	123855	3	310
180	4848-4	123854	3	310
181	4848-4	124846	3	310
182	4848-4	117949	3	310
183	4848-4	103849	3	310
184	4848-4	103849	3	310
185	4848-4	101849	3	310
186	4848-4	103841	3	310
187	4848-4	122813	3	310
188	4848-4	122814	3	310
189	4848-4	136825	3	297
190	4848-4	144822	3	297
191	4848-4	144824	3	297
192	4848-4	139825	3	297
193	4848-4	118815	3	297
194	4848-4	144856	3	297
195	4848-4	146856	3	297
196	4848-4	133863	3	310
197	4848-4	133852	3	297
198	4848-3	102610	3	306
199	4848-3	102609	3	306
200	4848-3	104610	3	305

APPENDIX A. (continued)

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
201	4848-3	105609	3	305
202	4848-3	130668	3	306
203	4848-3	130668	3	306
204	4848-3	132583	3	306
205	4848-3	137569	3	301
206	4848-3	151586	3	301
207	4848-3	155590	3	301
208	4848-3	146588	3	301
209	4748-1	977875	3	28
210	4748-1	976875	3	28
211	4748-1	976876	3	28
212	4748-1	967881	3	28
213	4748-2	867479	3	54
214	4748-2	853452	3	54
215	4748-2	883443	3	54
216	4748-2	893463	3	54
217	4748-2	888458	3	54
218	4747-1	968382	3	104
219	4747-1	968382	3	104
220	4747-1	968378	3	104
221	4848-3	72575	3	306
222	4848-3	98599	3	306
223	4848-3	98599	3	306
224	4848-3	145667	3	299
225	4848-3	146668	3	299
226	4848-3	148668	3	299
227	4848-3	148668	3	299
228	4848-3	140660	3	299
229	4848-3	148669	3	299
230	4848-3	149669	3	299
231	4848-3	150671	3	299
232	4848-3	149671	3	299
233	4848-3	146670	3	299
234	4848-3	146670	3	299
235	4848-3	132585	3	306
236	4848-3	133586	3	306
237	4848-3	134583	3	306
238	4848-3	147615	3	301
239	4848-3	152623	3	301
240	4848-4	117711	3	308
241	4749-2	989781	3	25
242	4749-2	995771	3	25
243	4749-2	45851	3	310
244	4749-2	43851	3	310
245	4749-2	54859	3	10
246	4749-2	46899	3	10
247	4848-4	81906	3	310
248	4848-4	186905	3	295
249	4848-3	101610	3	306
250	4848-3	104610	3	305

APPENDIX A. (continued)

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
251	4848-3	105616	3	306
252	4848-3	114659	3	306
253	4848-3	141563	3	301
254	4848-3	147566	3	301
255	4848-3	135586	3	306
256	4848-3	135587	3	306
257	4848-3	136587	3	306
258	4847-4	94635	1	129
259	4849-3	72082	3	314
260	4748-2	25469	3	19
261	4848-3	62444	3	19
262	4748-2	39524	3	18
263	4848-3	68513	1	73
264	4848-3	136505	3	304
265	4748-2	916574	1	44
266	4748-2	947594	1	44
267	4748-2	22653	1	16
268	4748-1	12693	1	16
269	4849-3	127005	3	313
270	4849-3	198063	3	292
271	4849-3	180177	3	292
272	4849-3	197101	3	292
273	4849-3	165113	3	291
274	4748-1	828775	3	49
275	4748-1	823773	3	49
276	4749-3	58077	3	315
277	4849-3	72082	3	314
278	4849-3	113104	3	291
279	4849-3	84084	3	315
280	4849-3	92028	3	313
281	4849-3	84019	3	313
282	4848-4	193734	3	299
283	4848-4	118693	3	308
284	4848-4	205746	3	298
285	4848-4	257714	3	268
286	4848-4	258715	3	268
287	4848-4	719267	3	268
288	4848-4	284749	3	268
289	4747-1	957286	1	132
290	4848-4	234932	3	271
291	4848-4	208824	3	296
292	4848-4	289885	3	271
293	4748-1	18855	3	27
294	4748-4	28884	3	11
295	4748-4	36924	3	12
296	4848-3	87517	1	304
297	4847-4	157213	1	166
298	4849-3	193063	3	291
299	4748-1	994827	3	27
302	4849-3	127005	3	313

APPENDIX A. (continued)

Location of Sample Sites at Fort Bliss and Adjacent Areas.

SITE NUMBER	TOPOGRAPHIC SHEET NUMBER	GRID COORDINATES	PHOTO MOSAIC	PHOTO NUMBER
303	4849-[illegible]	87977	3	312
304	4848-3	87517	1	304

APPENDIX B.

PARTICLE SIZE ANALYSIS OF SOIL SAMPLES.

SAMPLE NUMBER	SITE NUMBER	DEPTH FROM SURFACE (CM)	PERCENT OF SAMPLE FINER THAN 2.0 (MM)	1.0 (MM)	0.5 (MM)	0.25 (MM)	0.05 (MM)	0.002 (MM)	SOIL TEXTURE CLASSIFICATION
1	9	0- 10	100	100	98	67	16	13	LOAMY SAND
2	15	0- 10	100	100	100	99	88	56	CLAY
3	17	0- 10	97	97	97	97	64	36	CLAY LOAM
4	18	0- 10	86	85	85	84	42	24	SANDY CLAY LOAM
5	32	0- 10	92	92	92	81	36	29	SANDY CLAY LOAM
6	36	0- 10	100	100	100	82	21	17	SANDY LOAM
7	41	0- 10	93	93	93	91	39	25	SANDY CLAY LOAM
8	44	0- 10	78	77	77	73	50	26	GRAVELLY CLAY LOAM
9	46	0- 10	75	72	71	70	46	19	GRAVELLY SANDY CLAY LOAM
10	47	0- 10	86	84	73	62	38	29	SANDY CLAY LOAM
11	53	0- 10	100	100	99	84	35	25	SANDY CLAY LOAM
12	55	0- 10	100	100	98	63	23	19	SANDY LOAM
13	67	0- 10	100	100	100	100	82	38	SILTY CLAY LOAM
14	68	0- 10	97	94	80	47	18	15	SANDY LOAM
16	130	0- 15	100	100	97	79	27	21	SANDY CLAY LOAM
17	130	15- 30	99	99	95	74	31	24	SANDY CLAY LOAM
18	130	30- 46	99	99	95	75	28	21	SANDY CLAY LOAM
19	130	46- 61	97	97	93	73	35	26	SANDY CLAY LOAM
20	130	61- 76	97	96	91	68	24	16	SANDY LOAM
24	133	0- 25	99	98	92	67	27	19	SANDY LOAM
25	133	25- 48	100	99	92	58	45	35	SANDY CLAY LOAM
26	133	48- 61	99	97	88	62	41	34	SANDY CLAY LOAM
28	135	0- 25	97	97	93	68	25	20	SANDY LOAM
29	136	0- 3	94	93	87	76	44	13	SANDY LOAM
30	136	3- 23	95	94	91	84	55	17	LOAM
31	136	23- 38	95	93	90	84	45	27	SANDY CLAY LOAM
32	136	38- 53	72	69	66	60	51	29	GRAVELLY CLAY LOAM
33	141	0- 38	70	67	65	62	41	21	GRAVELLY CLAY LOAM
34	142	0- 13	89	88	87	86	44	19	SANDY CLAY LOAM
35	142	13- 36	82	80	79	74	46	17	LOAM
36	144	0- 23	68	67	66	65	35	14	GRAVELLY LOAM

APPENDIX B. (Continued)

PARTICLE SIZE ANALYSIS OF SOIL SAMPLES.

SAMPLE NUMBER	SITE NUMBER	DEPTH FROM SURFACE (CM)	PERCENT OF SAMPLE FINER THAN 2.0 (MM)	1.0 (MM)	0.5 (MM)	0.25 (MM)	0.05 (MM)	0.002 (MM)	SOIL TEXTURE CLASSIFICATION
37	146	0- 15	88	87	87	85	40	20	SANDY CLAY LOAM
38	146	15- 41	76	74	73	68	35	14	GRAVELLY SANDY LOAM
39	149	0- 15	100	100	100	99	57	31	CLAY LOAM
40	149	15- 30	100	100	100	99	58	31	CLAY LOAM
41	149	30- 61	100	100	100	99	80	32	CLAY LOAM
42	303	0- 15	100	100	100	95	55	37	SANDY CLAY
43	303	15- 30	100	100	100	94	48	30	SANDY CLAY LOAM
44	152	0- 10	100	100	100	92	66	43	CLAY
45	152	10- 41	100	100	100	85	35	27	SANDY CLAY LOAM
48	154	0- 10	91	90	90	89	51	26	CLAY LOAM
49	154	10- 30	88	86	85	84	52	31	CLAY LOAM
50	154	30- 46	78	73	72	69	45	29	GRAVELLY CLAY LOAM
52	155	0- 15	98	97	87	63	21	17	SANDY LOAM
53	155	15- 41	97	96	89	62	33	27	SANDY CLAY LOAM
54	155	41- 61	99	97	88	61	40	38	SANDY CLAY
55	157	0- 30	99	99	94	68	44	44	SANDY CLAY
56	157	30- 46	97	95	84	61	48	38	SANDY CLAY
57	158	0- 15	100	100	96	68	31	25	SANDY CLAY LOAM
58	158	15- 46	99	99	93	77	46	30	SANDY CLAY LOAM
59	158	46- 61	98	97	90	61	44	36	SANDY CLAY LOAM
64	299	0- 15	65	64	63	60	30	17	GRAVELLY SANDY CLAY LOAM
65	159	0- 23	100	100	99	81	23	17	SANDY LOAM
66	159	23- 38	100	100	97	73	50	36	SANDY CLAY
67	159	38- 51	100	100	97	67	35	29	SANDY CLAY LOAM
68	160	0- 15	82	80	79	78	48	25	CLAY LOAM
69	160	15- 61	75	73	72	70	46	23	GRAVELLY CLAY LOAM
70	162	0- 13	98	98	98	95	66	35	CLAY LOAM
71	162	13- 30	71	66	64	56	43	29	GRAVELLY CLAY
72	163	0- 15	99	99	99	96	63	35	CLAY LOAM
73	163	15- 30	90	89	86	82	58	38	CLAY LOAM
74	163	30- 46	99	99	97	93	68	42	CLAY

APPENDIX B. (Continued)

PARTICLE SIZE ANALYSIS OF SOIL SAMPLES.

SAMPLE NUMBER	SITE NUMBER	DEPTH FROM SURFACE (CM)	PERCENT OF SAMPLE FINER THAN 2.0 (MM)	1.0 (MM)	0.5 (MM)	0.25 (MM)	0.05 (MM)	0.002 (MM)	SOIL TEXTURE CLASSIFICATION
76	164	0- 15	100	100	100	90	77	43	CLAY
77	164	15- 30	99	99	99	99	80	54	CLAY
79	165	0- 13	80	76	72	61	54	28	GRAVELLY CLAY LOAM
80	165	13- 25	65	59	54	47	43	22	GRAVELLY CLAY LOAM
81	166	0- 15	72	68	66	63	45	23	GRAVELLY CLAY LOAM
82	166	15- 30	72	69	68	65	48	23	GRAVELLY CLAY LOAM
85	168	0- 10	70	63	55	46	28	14	GRAVELLY SANDY LOAM
86	168	10- 30	65	57	48	39	35	18	GRAVELLY SANDY CLAY LOAM
90	171	0- 13	100	100	94	73	35	27	SANDY CLAY LOAM
91	171	13- 38	100	100	95	72	37	29	SANDY CLAY LOAM
92	171	38- 61	96	95	87	66	41	33	SANDY CLAY
96	173	0- 20	100	100	98	79	22	16	SANDY LOAM
97	173	20- 53	100	100	98	74	20	16	SANDY LOAM
98	173	53- 66	100	100	97	75	31	27	SANDY CLAY LOAM
99	175	0- 15	100	100	100	76	17	15	LOAMY SAND
100	175	15- 46	100	100	98	67	28	24	SANDY CLAY LOAM
101	106	0- 15	98	98	96	79	21	18	SANDY LOAM
102	106	15- 46	95	94	91	71	28	21	SANDY CLAY LOAM
103	179	0- 10	100	99	98	97	70	36	CLAY LOAM
104	186	0- 16	74	72	71	70	38	22	GRAVELLY SANDY CLAY LOAM
105	190	0- 15	79	74	67	57	48	17	GRAVELLY SILT LOAM
106	189	0- 16	86	86	85	85	77	44	CLAY
107	199	0- 15	71	69	68	62	45	32	GRAVELLY CLAY LOAM
108	199	15- 30	93	92	91	87	85	70	CLAY
109	198	0- 10	75	72	70	68	47	23	GRAVELLY CLAY LOAM
110	201	0- 16	83	80	79	78	50	27	CLAY LOAM
111	216	0- 16	100	100	99	82	21	15	SANDY LOAM
112	217	0- 16	100	100	98	78	22	15	SANDY LOAM
113	222	0- 16	84	83	83	83	81	53	CLAY
114	256	0- 16	89	87	81	61	57	56	CLAY
115	241	0- 16	100	100	99	72	17	12	LOAMY SAND

APPENDIX B. (Continued)

PARTICLE SIZE ANALYSIS OF SOIL SAMPLES.

SAMPLE NUMBER	SITE NUMBER	DEPTH FROM SURFACE (CM)	PERCENT OF SAMPLE FINER THAN 2.0 (MM)	1.0 (MM)	0.5 (MM)	0.25 (MM)	0.05 (MM)	0.002 (MM)	SOIL TEXTURE CLASSIFICATION
116	251	0- 16	83	82	80	75	51	31	CLAY LOAM
117	243	0- 16	100	100	99	73	18	14	SANDY LOAM
118	244	0- 16	100	100	100	71	11	10	LOAMY SAND
119	245	0- 16	100	100	99	79	18	15	SANDY LOAM
120	247	0- 16	100	100	98	78	11	11	LOAMY SAND
121	246	0- 16	100	100	100	93	16	13	LOAMY SAND
122	181	0- 16	74	69	64	61	46	24	GRAVELLY CLAY LOAM
123	183	0- 16	95	95	95	92	72	41	CLAY
124	185	0- 16	100	100	98	95	87	48	CLAY
125	187	0- 16	69	67	65	62	44	25	GRAVELLY CLAY
126	188	0- 16	94	93	92	91	45	19	SANDY CLAY LOAM
127	196	0- 16	71	69	68	67	44	22	GRAVELLY CLAY LOAM
128	200	0- 16	88	87	87	86	57	29	CLAY LOAM
129	202	0- 16	89	87	86	82	49	22	LOAM
130	203	0- 16	82	79	78	77	46	26	CLAY LOAM
131	204	0- 16	83	81	80	79	54	33	CLAY LOAM
132	205	0- 16	100	100	100	100	83	43	CLAY
133	206	0- 16	65	61	59	57	45	21	GRAVELLY CLAY LOAM
134	207	0- 16	83	81	81	80	53	26	CLAY LOAM
135	208	0- 16	81	79	76	73	37	24	SANDY CLAY LOAM
136	210	0- 16	91	89	85	76	46	30	SANDY CLAY LOAM
137	212	0- 16	68	60	48	37	22	14	GRAVELLY SANDY CLAY LOAM
138	213	0- 16	100	100	98	78	22	17	SANDY LOAM
139	214	0- 16	100	100	99	89	21	14	SANDY LOAM
140	215	0- 16	100	100	99	87	26	16	SANDY LOAM
141	253	0- 16	83	81	79	79	76	59	CLAY
142	254	0- 16	93	93	92	92	91	79	CLAY
144	221	0- 15	100	98	98	95	86	44	SILTY CLAY
145	223	0- 16	87	87	87	87	84	70	CLAY
146	224	0- 15	68	62	60	58	43	26	GRAVELLY CLAY LOAM
147	224	15- 30	81	77	74	73	69	50	CLAY

APPENDIX B. (Continued)

PARTICLE SIZE ANALYSIS OF SOIL SAMPLES.

SAMPLE NUMBER	SITE NUMBER	DEPTH FROM SURFACE (CM)	PERCENT OF SAMPLE FINER THAN 2.0 (MM)	1.0 (MM)	0.5 (MM)	0.25 (MM)	0.05 (MM)	0.002 (MM)	SOIL TEXTURE CLASSIFICATION
148	225	0- 16	78	76	73	69	68	56	GRAVELLY CLAY
149	226	0- 16	82	80	79	77	67	42	CLAY
150	227	0- 16	96	96	96	96	93	80	CLAY
151	228	0- 16	96	98	98	98	98	86	CLAY
152	229	0- 16	67	63	61	57	45	27	GRAVELLY CLAY LOAM
153	231	0- 16	97	95	94	94	93	78	CLAY
154	233	0- 3	66	61	59	55	39	20	GRAVELLY CLAY LOAM
155	233	3- 16	73	69	66	62	55	34	GRAVELLY CLAY
156	234	0- 16	95	94	93	91	74	33	CLAY LOAM
157	236	0- 16	79	75	73	71	48	27	GRAVELLY CLAY LOAM
158	237	0- 16	78	75	73	71	61	31	GRAVELLY CLAY LOAM
159	238	0- 16	99	99	99	98	75	41	CLAY
160	239	0- 16	81	78	77	71	56	28	CLAY LOAM
161	240	0- 16	97	97	96	91	89	48	SILTY CLAY
162	255	0- 9	68	63	60	56	52	29	GRAVELLY CLAY
163	255	9- 26	75	72	72	72	67	49	GRAVELLY CLAY
164	257	0- 16	92	91	88	84	81	63	CLAY
165	264	0- 15	78	76	74	72	53	24	GRAVELLY CLAY LOAM
166	264	15- 30	83	79	78	77	61	28	CLAY LOAM
167	265	0- 15	100	100	99	94	69	50	CLAY
169	266	0- 15	100	100	100	98	54	27	SANDY CLAY LOAM
170	267	0- 15	100	100	100	100	0	0	SAND
171	268	0- 15	62	10	7	6	23	12	GRAVELLY SANDY CLAY LOAM
172	302	0- 15	100	100	100	100	75	37	CLAY LOAM
173	269	0- 15	100	100	100	100	95	51	SILTY CLAY
174	270	0- 15	100	100	100	99	9	6	SAND
175	273	0- 15	100	100	100	100	77	29	CLAY LOAM
176	274	0- 15	100	100	99	75	21	13	SANDY LOAM
177	274	15- 30	100	100	99	77	23	14	SANDY LOAM
178	275	0- 15	99	99	97	70	24	18	SANDY LOAM
179	275	15- 30	99	99	97	70	32	23	SANDY CLAY LOAM

APPENDIX B. (Continued)

PARTICLE SIZE ANALYSIS OF SOIL SAMPLES.

SAMPLE NUMBER	SITE NUMBER	DEPTH FROM SURFACE (CM)	PERCENT OF SAMPLE FINER THAN 2.0 (MM)	1.0 (MM)	0.5 (MM)	0.25 (MM)	0.05 (MM)	0.002 (MM)	SOIL TEXTURE CLASSIFICATION
180	276	0- 15	100	100	99	80	22	15	SANDY LOAM
181	277	0- 15	100	100	100	99	82	45	CLAY
182	278	0- 15	100	100	100	95	13	12	LOAMY SAND
184	279	0- 15	100	100	100	95	30	19	SANDY LOAM
185	280	0- 15	100	100	100	86	30	19	SANDY LOAM
186	281	0- [illegible]	100	100	100	100	82	53	CLAY
187	283	0- 15	79	77	73	69	62	39	GRAVELLY CLAY
188	283	15- 30	94	94	94	92	90	74	CLAY
190	284	0- 15	100	100	100	100	75	56	CLAY
191	286	0- 15	82	81	81	81	48	25	CLAY LOAM
192	290	0- 15	91	90	89	88	39	18	SANDY CLAY LOAM
193	292	0- 15	98	98	98	97	24	13	SANDY LOAM
194	293	0- 15	100	100	100	81	14	12	LOAMY SAND
195	293	15- 60	99	99	98	84	20	14	SANDY LOAM
196	293	60- 75	99	99	98	84	19	15	SANDY LOAM
197	294	0- 22	99	98	97	94	47	29	CLAY
198	294	22- 37	93	92	90	87	70	66	CLAY
199	295	0- 15	100	100	98	90	32	23	SANDY CLAY LOAM
200	295	15- 37	100	100	97	87	32	24	SANDY CLAY LOAM
201	271	0- 15	100	100	100	100	47	24	SANDY CLAY LOAM
202	271	396-410	100	100	100	95	15	12	LOAMY SAND
203	304	0- 15	100	100	100	100	84	43	SILTY CLAY
204	304	15- 30	100	100	100	100	90	48	SILTY CLAY
205	300	0- 15	99	95	82	58	21	12	SANDY LOAM
206	300	0- 3	100	99	83	56	44	38	SANDY CLAY

APPENDIX C

Soil Summary for Landform A1.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT	---------			------PERCENT	------			
154	48	0- 10	9	44	28	28	17	10	7	8.3	70
154	49	10- 30	12	41	24	35	19	9	10	8.2	76
154	50	30- 46	22	44	20	36	21	10	11	8.2	77
200	128	0- 16	12	37	32	32	21	11	9	7.9	144
201	110	0- 16	17	39	28	33	18	9	9	8.1	83
202	129	0- 16	11	45	30	25	13	7	6	7.9	115
203	130	0- 16	18	43	25	32	16	8	8	8.0	134
251	116	0- 16	17	39	24	37	20	11	10	7.6	96
286	191	0- 15	18	43	29	29	15	8	6		

APPENDIX C. (Continued)

Soil Summary for Landform A2.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
46	9	0- 10	25	38	36	26	20	8	12	8.0	99
165	79	0- 13	20	32	32	36	19	11	8	8.3	91
165	80	13- 25	35	34	32	34	21	10	11	8.5	102
181	122	0- 16	26	39	30	31	16	7	9	7.6	125
187	125	0- 16	31	35	28	37	20	10	10	7.7	131
196	127	0- 16	29	39	31	30	20	8	11	7.7	154
198	109	0- 10	25	37	33	30	20	10	9		
199	107	0- 15	29	36	24	40	15	9	6	8.2	83
199	108	15- 30	7	9	16	75	24	17	7	8.3	122
222	113	0- 16	16	3	21	76	22	14	8	7.9	205
223	145	0- 16	13	4	16	80	29	20	9	8.1	230
224	146	0- 15	32	37	25	38	16	10	6	8.1	86
224	147	15- 30	19	15	23	62	23	17	6	8.1	166
225	148	0- 16	22	13	16	71	24	16	8	8.3	102
226	149	0- 16	18	20	32	48	22	10	12	8.3	99
227	150	0- 16	4	3	14	83	24	15	9	8.4	288
228	151	0- 16	2	0	12	88	26	17	8	8.2	102
229	152	0- 16	33	33	27	40	18	11	6	7.9	83
231	153	0- 16	3	4	15	81	26	19	7	7.9	160
233	154	0- 3	34	41	28	31	17	8	8	7.5	77
233	155	3- 16	27	25	29	46	20	13	7	7.7	90
234	156	0- 16	5	21	43	36	23	13	10	7.7	90
236	157	0- 16	21	40	26	34	18	10	8	7.8	96
237	158	0- 16	22	22	39	39	23	13	9	7.9	96
239	160	0- 16	19	32	34	34	21	11	10	8.0	96
253	141	0- 16	17	7	21	72	27	17	10	7.7	154
254	142	0- 16	7	3	13	84	26	18	9	7.8	173
255	162	0- 9	32	24	34	42	19	11	8	8.0	90
255	163	9- 26	25	10	24	66	25	17	8	8.0	339
256	114	0- 16	11	4	2	77	25	18	8	7.6	179
257	164	0- 16	8	11	20	69	28	19	9	7.9	192
264	165	0- 15	22	32	37	31	21	11	10		
264	166	15- 30	17	28	39	33	22	12	11		
270	174	0- 15	0	90	1	9	2	2	0		
283	187	0- 15	21	22	29	49	24	12	12		
283	188	15- 30	6	4	17	79	30	17	13		
299	61	0- 15	35	54	20	26	13	7	6	8.5	65

APPENDIX C. (Continued)

Soil Summary for Landform B1.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
18	4	0- 10	14	52	21	27	14	6	8	8.2	77
141	33	0- 38	30	42	29	29	16	7	9	8.2	67
142	34	0- 13	11	32	34	34	21	11	10	7.9	86
142	35	13- 36	18	32	32	36	23	11	11	8.1	84
144	36	0- 23	32	44	30	26	16	8	8	8.2	64
146	37	0- 15	12	56	23	21	13	7	6	8.2	70
146	38	15- 41	24	48	26	26	16	8	9	8.1	64
168	85	0- 16	30	61	20	19	11	6	6	7.9	72
168	86	16- 30	35	57	24	24	15	7	8	8.1	84
183	123	0- 16	5	25	33	42	24	12	12	7.6	198
186	104	0- 16	26	49	22	29	15	7	9	7.8	70
188	126	0- 16	6	51	28	21	12	6	6	7.8	131
189	106	0- 16	14	10	38	51	30	12	18	8.5	166
190	105	0- 15	21	31	45	24	25	16	10		
204	131	0- 16	17	36	26	38	19	11	8	8.0	134
206	133	0- 16	35	30	37	33	21	12	9	7.8	160
207	134	0- 16	17	35	33	32	22	11	12	7.9	154
208	135	0- 16	19	55	16	29	11	5	5	8.0	86
212	137	0- 16	32	68	12	21	11	6	5	7.8	83
238	159	0- 16	1	24	34	42	25	16	9	8.0	112
268	171	0- 15	38	24	34	42	23	14	9		
290	192	0- 15	9	48	24	28	16	7	9		

APPENDIX C. (Continued)

Soil Summary for Landform B3.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
17	3	0- 10	3	34	29	37	17	8	10	8.1	83
41	7	0- 10	7	58	15	27	11	5	6	8.7	70
136	29	0- 3	6	54	18	28	13	7	6	8.6	80
136	30	3- 23	5	42	21	32	16	8	9	8.4	83
136	31	23- 38	5	52	19	29	12	7	6	8.1	74
136	32	38- 53	28	66	17	17	11	6	5	8.1	77
149	39	0- 15	0	44	26	30	15	8	6	8.3	83
149	40	15- 30	0	42	27	31	14	6	8	8.5	59
149	41	30- 61	0	38	44	28	14	7	7	8.3	76
163	72	0- 15	1	38	28	34	19	9	10	8.5	96
163	73	15- 30	10	36	22	42	19	13	7	8.7	109
163	74	30- 46	1	32	26	42	20	11	9	7.9	116
166	81	0- 15	28	37	30	33	17	8	9	8.1	84
166	82	15- 30	28	34	34	32	17	11	6	8.1	97
175	99	0- 15	0	85	2	14	4	3	1	8.0	33
175	100	15- 46	0	72	4	24	7	4	2	8.6	77
267	170	0- 15	0	0	36	64	37	23	14		
273	175	0- 15	0	24	48	29	19	7	12		

APPENDIX C. (Continued)

Soil Summary for Landform B4.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
15	2	0- 10	0	4	38	58	27	13	15	7.9	109
44	8	0- 10	22	37	31	32	21	10	11	7.8	173
47	10	0- 10	14	56	11	33	17	7	10	8.0	115
152	44	0- 10	0	35	23	42	21	13	8	8.0	224
152	45	10- 41	0	65	8	27	8	5	3	8.3	116
160	68	0- 15	18	42	28	30	17	8	8	8.9	77
160	69	15- 61	25	40	30	30	18	8	11	8.5	61
162	70	0- 13	2	33	32	35	24	11	13	8.5	115
162	71	13- 30	29	40	20	40	20	10	10	7.9	122
185	124	0- 16	0	13	39	48	32	16	16	7.4	352
269	173	0- 15	0	5	44	52	32	17	15		
271	201	0- 15	0	53	23	23	15	6	9		
271	202	396-410	0	85	3	12	4	2	2		
281	186	0- 15	0	17	32	51	27	13	13		
294	197	0- 22	1	53	18	29	17	9	8		
294	198	22- 37	7	52	14	34	17	9	8		
302	172	0- 15	0	26	38	36	22	12	11		
303	42	0- 15	0	46	18	36	17	10	7	8.4	97
303	43	15- 30	0	52	18	30	13	7	6	8.4	100

APPENDIX C. (Continued)

Soil Summary for Landform B5.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
216	136	0- 16	9	49	18	33	17	9	8	8.3	102

APPENDIX C. (Continued)

Soil Summary for Landform C1.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT			---------	------PERCENT		------		
9	1	0- 10	0	85	3	12	4	2	2	8.2	48
53	11	0- 10	0	65	10	25	10	4	6	8.6	96
55	12	0- 10	0	77	4	19	4	2	2	8.2	40
67	13	0- 10	0	18	44	38	22	10	12	8.2	102
68	14	0- 10	3	82	3	15	6	4	3	8.5	51
135	28	0- 25	3	76	6	19	7	5	3	8.4	70
155	52	0- 15	2	79	4	17	7	4	3	8.6	48
155	53	15- 41	3	65	6	29	12	7	5	8.2	65
155	54	41- 61	1	59	2	39	15	8	7	8.5	70
157	55	0- 30	1	71	8	21	9	6	4	8.3	70
157	56	30- 46	3	50	10	40	16	9	8	8.6	69
158	57	0- 15	0	69	6	25	7	4	3	8.3	45
158	58	15- 46	1	54	16	30	12	6	5	8.7	70
158	59	46- 61	2	56	8	36	16	9	7	8.4	67
159	65	0- 23	0	78	6	16	6	4	1	7.9	44
159	66	23- 38	0	74	8	18	7	5	3	8.2	48
159	67	38- 61	0	66	6	28	9	6	3	8.4	49
171	90	0- 13	0	65	8	27	8	5	3	8.2	54
171	91	13- 38	0	63	8	29	10	6	4	8.3	59
171	92	38- 61	4	57	8	35	13	8	5	8.2	63
216	141	0- 16	0	80	7	14	4	3	1	8.2	38
276	180	0- 15	0	78	7	15	6	3	2		
278	182	0- 15	0	87	1	12	3	2	1		
279	184	0- 15	0	38	20	42	18	11	7		
280	185	0- 15	0	71	11	18	8	5	3		
295	199	0- 15	0	69	9	22	9	5	4		
295	200	15- 37	0	69	8	24	11	6	6		

APPENDIX C. (Continued)

Soil Summary for Landform C2.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
36	6	0- 10	0	79	4	17	5	3	2	6.5	58
241	115	0- 16	0	83	6	12	3	2	1	7.8	179
243	117	0- 16	0	82	5	13	4	2	1	7.8	38
244	118	0- 16	0	89	1	10	2	2	0	7.9	17
245	119	0- 16	0	82	4	15	5	3	2	8.0	42
247	120	0- 16	0	89	1	11	3	2	1	7.8	19
274	176	0- 15	0	79	8	13	4	1	3		
274	177	15- 30	0	77	9	14	5	4	1		
292	193	0- 15	2	76	11	13	7	4	2		
293	194	0- 15	0	87	2	11	2	2	0		
293	195	15- 60	1	79	6	15	5	4	1		
293	196	60- 75	1	81	4	15	5	4	1		

APPENDIX C. (Continued)

Soil Summary for Landform C4.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			--------PERCENT	--------	--------	--------	------PERCENT	------	------		
32	5	0- 10	8	62	8	30	10	5	5	8.5	64
106	101	0- 15	2	76	3	18	8	5	4	8.3	45
106	102	15- 46	5	71	7	22	12	6	6	8.2	54
130	16	0- 15	0	74	6	21	6	5	2	8.5	58
130	17	15- 30	1	70	7	24	8	5	3	8.5	58
130	18	30- 46	1	71	7	21	8	5	3	8.4	58
130	19	46- 61	3	65	9	26	9	6	3	8.5	70
130	20	61- 76	3	75	8	18	7	4	2	8.6	54
133	24	0- 25	1	73	8	19	7	5	3	8.4	58
133	25	25- 48	0	56	10	34	13	8	5	8.5	70
133	26	48- 61	1	58	7	35	14	8	6	8.5	70
173	96	0- 20	0	79	6	15	5	4	2	8.1	44
173	97	20- 53	0	81	4	15	7	4	3	8.1	47
173	98	53- 66	0	69	4	27	8	5	2	8.1	48
213	138	0- 16	0	79	5	16	7	4	3	7.8	42
214	139	0- 16	0	79	7	14	7	3	4	8.0	70
215	140	0- 16	0	75	10	16	8	4	4	8.0	67
217	112	0- 16	0	79	7	15	5	3	2	7.5	38
246	121	0- 16	0	85	4	12	4	3	1	7.8	26
265	167	0- 15	0	65	15	20	11	6	5		
266	169	0- 15	0	24	26	50	22	13	9		
275	178	0- 15	1	76	6	18	9	6	3		
275	179	15- 30	1	68	9	23	13	8	6		
277	181	0- 15	0	18	37	45	23	15	8		

APPENDIX C. (Continued)

Soil Summary for Landform D.

SITE NUMBER	SAMPLE NUMBER	DEPTH FROM (CM)	GRAVEL	SAND	SILT	CLAY	SOIL MOISTURE* 0.3BAR	15BAR	PAW	PH	SALINITY (PPM)
			---------PERCENT---------				------PERCENT------				
164	76	0- 15	0	23	34	43	25	13	12	8.7	102
164	77	15- 30	1	20	26	54	22	12	10	8.1	84
179	173	0- 10	0	31	34	36	19	8	11	7.8	83
205	132	0- 16	0	17	40	43	29	16	13	8.1	182
221	144	0- 15	0	13	42	45	32	13	19	7.7	147
240	161	0- 16	3	8	42	50	32	20	11	7.9	147
284	190	0- 15	0	29	20	51	25	15	11		
304	203	0- 15	0	16	41	43	24	11	13		
304	204	15- 30	0	10	42	48	27	13	14		

APPENDIX D.

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
100.0	BARE GROUND	3	4	3	4	4	4	2	5	5	2	3	4	5	3	2	1	5	5	4	4	4	2	3	4	3	2
0.3	JUNIPERUS MONOSPERMA																										
0.3	QUERCUS UNDULATA																										
15.1	ACACIA CONSTRICTA				2	2																2					
0.3	AGAVE LECHEQUILLA																										
1.0	AGAVE PARRYI																										
0.7	ALOYSIA WRIGHTII																										
15.1	ARTEMISIA FILIFOLIA										2																2
25.1	ATRIPLEX CANESCENS		R					R	R	R	+	1		R	2								R	+			
6.5	BERBERIS TRIFOLIOLATA																										
12.7	DALEA FORMOSA																										
1.0	DALEA SCOPARIA																										
1.4	DASYLIRION WHEELERI																										
10.0	DYSSODIA ACEROSA																										
22.7	EPHEDRA SP.		R			o																					R
2.7	EUROTIA LANATA																										
25.8	FLOURENSIA CERNUA							3						+		2	3		1				2				
5.8	FOUQUIERIA SPLENDENS																										
3.4	KOEBERLINIA SPINOSA																										
2.1	KRAMERIA GLANDULOSA																										
56.7	LARREA TRIDENTATA	3	2	3	2	1	3	2					2	R	+			2	2	1	2	1	R			2	
2.4	NOLINA SP.																										
19.9	OPUNTIA SPP.	R			R	R										R					R					R	
23.7	PARTHENIUM INCANUM					R														1						1	
15.0	PROSOPIS GLANDULOSA	1		1					2	2	+	+		1	2		1		2	+	+	R		3	2		
0.7	RHUS AROMATICA																										
4.8	RHUS MICROPHYLLA																R		1								
1.0	THELESPERMA LONGIPES																										
4.9	VIGUIERA STENOLOBA																										
57.8	XANTHOCEPHALUM SAROTHRAE		1	1					+	R	+	+		R	+			R	2	2	2	+		+	2	1	1
4.8	YUCCA BACCATA				1	R													R	+				R			
33.0	YUCCA ELATA	2		R					+	+					2					+							+
6.5	YUCCA TORREYI														R												
16.9	GRASS SPP.							4						+				2			+						
4.1	ARISTIDA SP.																										
12.4	BOUTELOUA CURTIPENDULA																										
13.1	BOUTELOUA ERIOPODA																										
4.1	BOUTELOUA GRACILIS																										
3.1	BOUTELOUA HIRSUTA																										
0.3	CHLORIS VIRGATA																										
15.8	HILARIA MUTICA															4							4				
0.3	LYCURUS PHLEOIDES																										
6.5	MUHLENBERGIA ARENACEA																										
6.9	MUHLENBERGIA PORTERI																										
2.4	MUHLENBERGIA SETIFOLIA																										
1.0	PANICUM OBTUSUM																										
10.0	SCLEROPOGON BREVIFOLIUS																						1				
3.1	SETARIA MACROSTACHYA																										
2.7	SPOROBOLUS CONTRACTUS																4										
23.7	SPOROBOLUS CRYPTANDRUS										4	3												2	2		2
1.0	SPOROBOLUS FLEXUOSUS																										
1.0	SPOROBOLUS GIGANTEUS																										
6.9	SPOROBOLUS WRIGHTII												2														
0.3	STIPA PRINGLEI																										
0.3	TRICHACHNE CALIFORNICA																										
13.1	TRIDENS MUTICUS																									2	

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	400 27	400 28	400 29	400 30	400 31	400 32	400 33	400 34	400 35	400 36	400 37	400 38	400 39	400 40	400 41	400 42	400 43	400 44	400 45	400 46	400 47	400 48	400 49	400 50	400 51	400 52	400 53	400 54	400 55	400 56
100.0	BARE GROUND	3	4	2	3	3	4	3	2	2	4	4	4	4	4	5	4	4	3	5	4	3	3	3	3	4	4	4	5	5	4
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA																			2	2			1							
0.3	AGAVE LECHEGUILLA																														
1.0	AGAVE PARRYI																														
0.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA	2	2	1	2	2	+				2	1	1																		+
25.1	ATRIPLEX CANESCENS			+	+	+			R			R	+		R	R	R		R						1	1	+	+	+	R	+
6.5	BERBERIS TRIFOLIOLATA																			+	+			R							
12.7	DALEA FORMOSA																							R							
1.0	DALEA SCOPARIA				1	2														R											
1.4	DASYLIRION WHEELERI																														
10.0	DYSSODIA ACEROSA																														
22.7	EPHEDRA SP.	R									+	R								R				R				R		R	
2.7	EUROTIA LANATA																														
25.8	FLOURENSIA CERNUA							1	4	2									+			+	1		2						
5.8	FOUQUIERIA SPLENDENS																			R											
3.4	KOEBERLINIA SPINOSA																														
2.1	KRAMERIA GLANDULOSA																														
96.7	LARREA TRIDENTATA						2	3	R	2		R		2	1	2	2	2	2	+	+	+	2	R	R						
2.4	HOLINA SP.																														
19.9	OPUNTIA SPP.	R							R	R						R		+	R	+		+	+		R						
23.7	PARTHENIUM INCANUM							1					R					R		+	+			2							
15.0	PROSOPIS GLANDULOSA								R		1	R	+	2	2	1	1	+		R					R	2	2	2	2	R	2
0.7	RHUS AROMATICA																														
4.8	RHUS MICROPHYLLA																														
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA																														
57.0	XANTHOCEPHALUM SAROTHRAE	2			R		2			R	1	2	1	2	2	R	+	+		+	+					1	1	2	1	+	1
4.8	YUCCA BACCATA																														
33.0	YUCCA ELATA	1	1	1	+	+	+				+		+	+	+					R					R	+	+	1	+	+	+
6.5	YUCCA TORREYI																														
16.5	GRASS SPP.						+				1			2	2					1								R	+		
4.1	ARISTIDA SP.																														
12.4	BOUTELOUA CURTIPENDULA																							2							
13.1	BOUTELOUA ERIOPODA																														
4.1	BOUTELOUA GRACILIS																														
3.1	BOUTELOUA HIRSUTA																														
0.3	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA								5	2									2			5	2		2						
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA							1											1												
6.9	MUHLENBERGIA PORTERI							2								2	+	2													
2.4	MUHLENBERGIA SETIFOLIA																														
1.0	PANICUM OBTUSUM																														
10.0	SCLEROPOGON BREVIFOLIUS									2													1								
3.1	SETARIA MACROSTACHYA																														
2.7	SPOROBOLUS CONTRACTUS																														
23.7	SPOROBOLUS CRYPTANDRUS	2	2	2	2	2						1	2													1	1			2	2
1.0	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS																														
6.9	SPOROBOLUS WRIGHTII																								1						
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS																														

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
100.0	BARE GROUND	4	4	4	5	5	4	4	4	5	5	2	4	4	5	5
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA															+
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA															
25.1	ATRIPLEX CANESCENS		R	1	1	+					+	2	+	1		
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA						2	1	+	+						
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI															
10.0	DYSSODIA ACEROSA															
22.7	EPHEDRA SP.	+		+	+	+			R	R			1	+		
2.7	EUROTIA LANATA															
25.8	FLOURENSIA CERNUA															
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA		2			+	2	2		R					2	2
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.														R	
23.7	PARTHENIUM INCANUM															
15.0	PROSOPIS GLANDULOSA	R	2	2	2	1	R				2	2	2	2		
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA															R
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE	1	1	2	1		+	+			1	1		1		
4.8	YUCCA BACCATA														1	
33.0	YUCCA ELATA						R			R	+		R			
6.5	YUCCA TORREYI															
16.5	GRASS SPP.				+	R	+	R								
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA															
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA															
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA															
6.9	MUHLENBERGIA PORTERI															
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
10.0	SCLEROPOGON BREVIFOLIUS															
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS	2	+						2	2						
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII															
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS								1						1	

ABS. FREQ.	SPECIES	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
100.0	BARE GROUND	4	3	3	3	4	5	5	4	4	4	3	4	3	2	4
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA															
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA			R	+						R			+		
25.1	ATRIPLEX CANESCENS		R	+	1				+	+	+		R	R		
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA			3												2
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI															
10.0	DYSSODIA ACEROSA															R
22.7	EPHEDRA SP.							R	1		R	R				
2.7	EUROTIA LANATA															
25.8	FLOURENSIA CERNUA		2		2	2	+								2	
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA	2	2			2	2					2			+	1
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.															R
23.7	PARTHENIUM INCANUM	+														
15.0	PROSOPIS GLANDULOSA	+	2		+	+	+			2	2	1	2	R		
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA															
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE							2	1	1	1	2	1	1		1
4.8	YUCCA BACCATA															1
33.0	YUCCA ELATA			+	R					+	+	+	+	+		
6.5	YUCCA TORREYI							1								
16.5	GRASS SPP.	+			2		+			R	+	+	+			
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA															1
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA														3	
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA		2													
6.9	MUHLENBERGIA PORTERI					1										
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM		2													
10.0	SCLEROPOGON BREVIFOLIUS														2	
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS			1				1	2					2		
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII															
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS															

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES \ QUADRANT SIZE / QUADRANT NO.	400 87	400 88	400 89	400 90	400 91	400 92	400 93	400 94	400 95	400 96	400 97	400 98	400 99	400 100	400 101
100.0	BARE GROUND	2	3	3	4	2	2	4	5	5	1	4	3	4		2
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA			1	2			2	2			2				
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA					R	+									
25.1	ATRIPLEX CANESCENS														R	+
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA			2		2	2	2	+							
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI															
10.0	DYSSODIA ACEROSA			2	+				+				2	1		
22.7	EPHEDRA SP.			+	+	R	R		+							
2.7	EUROTIA LANATA															
25.6	FLOURENSIA CERNUA		1							2	2	+			2	2
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA	R	2			2				2		+	1	2		
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.	R		R	K	R						+	R	R	R	R
23.7	PARTHENIUM INCANUM				+							1				
15.0	PROSOPIS GLANDULOSA									R	R		R	+	R	
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA										R					
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE					R	+			+		1	1	2		
4.8	YUCCA BACCATA															
33.0	YUCCA ELATA						+	+						R		
6.5	YUCCA TORREYI															
16.5	GRASS SPP.							+	+					2		
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA			2	+	3	3									
13.1	BOUTELOUA ERIOPODA												3			
4.1	BOUTELOUA GRACILIS					2	2									
3.1	BOUTELOUA HIRSUTA											1				
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA	5								+	5				3	1
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA														R	
6.9	MUHLENBERGIA PORTERI															
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
18.0	SCLEROPOGON BREVIFOLIUS	2	3									2			1	4
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS															
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII					1										
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS											1	1			

ABS. FREQ.	SPECIES \ QUADRANT SIZE / QUADRANT NO.	400 102	400 103	400 104	400 105	400 106	400 107	400 108	400 109	400 110	400 111	400 112	400 113	400 114	400 115	400 116
100.0	BARE GROUND	4	4	5	4	4	2	4	4	3	5	5	4	4	5	4
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA									+						
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA					1		1	1							
25.1	ATRIPLEX CANESCENS			+	+	+		+	+	R						+
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA									+	1	2	1	1	+	
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI									+						
10.0	DYSSODIA ACEROSA															
22.7	EPHEDRA SP.	+					R		R				+			
2.7	EUROTIA LANATA															
25.6	FLOURENSIA CERNUA															
5.8	FOUQUIERIA SPLENDENS									R						
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA									+	2	2		2	2	K
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.									2	+	R	+	R		
23.7	PARTHENIUM INCANUM									+			R		1	
15.0	PROSOPIS GLANDULOSA	+	+	2	2	2	R	2	2	+			+	R		2
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA															
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE	2	2	1	1	2	+	1	1				2			1
4.8	YUCCA BACCATA									2						
33.0	YUCCA ELATA	+	+	+	+	+	+	+	+							
6.5	YUCCA TORREYI												+			
16.5	GRASS SPP.					+		+	+		+	+	+	+		
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA									2						
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA															
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA															
6.9	MUHLENBERGIA PORTERI															
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
18.0	SCLEROPOGON BREVIFOLIUS															
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS						4									
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII															
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS															

AP
APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES															
	QUADRANT SIZE	400	400	400	200	100	350	300	100	100	150	100	10u	100	100	5C
	QUADRANT NO.	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131
100.0	BARE GROUND	>	5	5	5	5	+	4	4	4	5	4	2	2	5	4
r.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA									1						
0.3	AGAVE LECHEQUILLA											1				
1.C	AGAVE PARRYI								+		1					
C.7	ALOYSIA WRIGHTII									+		+				
15.1	ARTEMISIA FILIFOLIA			1	1											
25.1	ATRIPLEX CANESCENS			+		2		+								
6.5	BERBERIS TRIFOLIOLATA								1							
12.7	DALEA FORMOSA	R							+	+	1			R	1	1
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI								+							
10.r	DYSSODIA ACEROSA															
22.7	EPHEDRA SP.			+					+	+						
2.7	EUROTIA LANATA												+	1		
75.8	FLOURENSIA CERNUA		+				1	2					1	1		
5.8	FOUQUIERIA SPLENDENS									1		+				
3.4	KOEBERLINIA SPINOSA									+						
2.1	KRAMERIA GLANDULOSA															
F6.7	LARREA TRIDENTATA	2	2				2	2	1	2	+	1	3	2	2	2
2.4	NOLINA SP.								1							
19.9	OPUNTIA SPP.									1	+	R	1	+		
23.7	PARTHENIUM INCANUM		+						1	1	2	2	2	2		
15.0	PROSOPIS GLANDULOSA		+	2	+		1	1			+		2	+	1	
0.7	RHUS AROMATICA								+							
4.8	RHUS MICROPHYLLA								+					+		
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA								1		+	1		1		
57.0	XANTHOCEPHALUM SAROTHRAE			1	+	+	+	1	1		1	1	1	1	1	1
4.8	YUCCA BACCATA															
33.r	YUCCA ELATA			1	2			1	+							
6.5	YUCCA TORREYI									1	R	+	1			
16.5	GRASS SPP.	R				R	2	1	2	2	1	2	1			
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA															
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA															
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA															
5.9	MUHLENBERGIA PORTERI															
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
10.0	SCLEROPOGON BREVIFOLIUS															
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS														2	
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII															2
0.7	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
1?.1	TRIDENS MUTICUS													+		1

ABS. FREQ.	SPECIES															
	QUADRANT SIZE	30	4C	30	3u	30	30	30	30	30	30	30	30	30	30	30
	QUADRANT NO.	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
100.0	BARE GROUND	4	5	4	4	4	+	4	5	4	5	3	4	4	4	5
r.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA															
0.3	AGAVE LECHEQUILLA															
1.C	AGAVE PARRYI															
C.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA															
25.1	ATRIPLEX CANESCENS		2	+												
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA	2														
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI															
10.r	DYSSODIA ACEROSA															
22.7	EPHEDRA SP.	1	+													
2.7	EUROTIA LANATA															
75.8	FLOURENSIA CERNUA											+				1
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
F6.7	LARREA TRIDENTATA			1	2	3	3	3	2	3	2	3	2	1	2	2
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.									+		+				
23.7	PARTHENIUM INCANUM											+	+	1	1	
15.0	PROSOPIS GLANDULOSA		1	3	2									2	+	
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA															
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE	1	1	1	2	1	+	1	+		+	2	1	2	2	
4.8	YUCCA BACCATA															
33.r	YUCCA ELATA											2				
6.5	YUCCA TORREYI															
16.5	GRASS SPP.								+					+		
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA															
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA															
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA												2			
5.9	MUHLENBERGIA PORTERI															1
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
10.0	SCLEROPOGON BREVIFOLIUS											1				
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS	2			1											
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII						1					1				
0.7	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
1?.1	TRIDENS MUTICUS						1						1		+	

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172
	QUADRANT SIZE	30	30	30	30	60	50	60	40	50	50	50	10	100	30	30	30	50	35	35	50	30	50	50	50	50	50
	QUADRANT NO.	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172
100.0	BARE GROUND	4	4	4	4	5	4	4	3	4	4	4	4	4	5	4	3	3	4	4	4	5	5	5	4	5	5
0.3	JUNIPERUS MONOSPERMA																										
0.3	QUERCUS UNDULATA																										
15.1	ACACIA CONSTRICTA																		1	2							
0.3	AGAVE LECHEQUILLA																										
1.0	AGAVE PARRYI																										
0.7	ALOYSIA WRIGHTII																										
15.1	ARTEMISIA FILIFOLIA						1	2																			
25.1	ATRIPLEX CANESCENS									1	1	+															
6.5	BERBERIS TRIFOLIOLATA																										
12.7	DALEA FORMOSA													+							1						
1.0	DALEA SCOPARIA																										
1.4	DASYLIRION WHEELERI																										
10.8	DYSSODIA ACEROSA																	+									
22.7	EPHEDRA SP.																			+						+	
2.7	EUROTIA LANATA																										
25.8	FLOURENSIA CERNUA	+	1				2	2	2								1	+		1		1					
5.8	FOUQUIERIA SPLENDENS																										
3.4	KOEBERLINIA SPINOSA																										
2.1	KRAMERIA GLANDULOSA																										
56.7	LARREA TRIDENTATA	2	2	2	3	2	1	2						2	2	2	1	2	2	2	2	2	2	2	2		
2.4	NOLINA SP.																										
19.9	OPUNTIA SPP.																										
23.7	PARTHENIUM INCANUM	1	1											+				2			1	2					
15.0	PROSOPIS GLANDULOSA	2						1		3	2	2		2		2	1	2					2	1	2	2	2
0.7	RHUS AROMATICA																										
4.8	RHUS MICROPHYLLA																	2	1								
1.0	THELESPERMA LONGIPES																										
4.8	VIGUIERA STENOLOBA																										
57.4	XANTHOCEPHALUM SAROTHRAE	2	1	4	1		+	+		1	2	2	1	2		+		+	R	1	1	+				2	2
4.8	YUCCA BACCATA																										
33.0	YUCCA ELATA						1	1										1			1	2					
6.5	YUCCA TORREYI																										
16.5	GRASS SPP.						2	2											2								
4.1	ARISTIDA SP.																										
12.4	BOUTELOUA CURTIPENDULA																										
13.1	BOUTELOUA ERIOPODA								2																		
4.1	BOUTELOUA GRACILIS																										
3.1	BOUTELOUA HIRSUTA																										
0.3	CHLORIS VIRGATA																										
15.8	HILARIA MUTICA								3									1	1								
0.3	LYCURUS PHLEOIDES																										
6.5	MUHLENBERGIA ARENACEA		2												1		2			1							
6.9	MUHLENBERGIA PORTERI	2	1														3	3									
2.4	MUHLENBERGIA SETIFOLIA																										
1.0	PANICUM OBTUSUM																										
10.0	SCLEROPOGON BREVIFOLIUS								R										1								
3.1	SETARIA MACROSTACHYA								1																		
2.7	SPOROBOLUS CONTRACTUS																										
23.7	SPOROBOLUS CRYPTANDRUS									1	2	2	2	2					1							+	2
1.0	SPOROBOLUS FLEXUOSUS																										
1.0	SPOROBOLUS GIGANTEUS																										
6.9	SPOROBOLUS WRIGHTII			1	2	1			2																		
0.3	STIPA PRINGLEI																										
0.3	TRICHACHNE CALIFORNICA																										
13.1	TRIDENS MUTICUS	+			R										R	2				1	1	1					1

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202
	QUADRANT SIZE	60	50	50	50	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
100.0	BARE GROUND	4	4	5	5	4	4	2	4	5	5	2	2	2	4	3	3	4	5	4	2	3	4	3	4		2	4	2	2	3
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA					2	R		1	R	+					1		+	+			2	2	1		+		2			
0.3	AGAVE LECHEQUILLA																														
1.0	AGAVE PARRYI																														
0.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA	+																													
[illegible]	ATRIPLEX CANESCENS								+				+	+			+				+										
6.5	BERBERIS TRIFOLIOLATA																		+				R	+			+	+	1		
12.7	DALEA FORMOSA			+																								+			
1.0	DALEA SCOPARIA																														
1.4	DASYLIRION WHEELERI																														
10.0	LYSSODIA ACEROSA					R	R									R				+		+	1	1			1	+			
22.7	EPHEDRA SP.	1					R			+	+							R	+		+	R	R	R			+	R			
2.7	EUROTIA LANATA																												R	+	+
25.8	FLOURENSIA CERNUA					1		+	+	+	1	2	3	2			1	R		+	3	+	+								R
5.8	FOUQUIERIA SPLENDENS						R				+							R				+									
3.4	KOEBERLINIA SPINOSA								+		+											+									
2.1	KRAMERIA GLANDULOSA																										2				
56.7	LARREA TRIDENTATA			2	2	1	R	+	+	R	1	R	+	R	2	R	2	R	+	2	1	1	1	1	2	2	+		+	2	1
2.4	NOLINA SP.										2																				
19.9	OPUNTIA SPP.					+						+	+			+	+					R	+	R				R			
23.7	PARTHENIUM INCANUM			1	1	+	1		1	1	R				1	R		R				R	R		1	2		1			
15.0	PROSOPIS GLANDULOSA					+		+	+				1	1	R	+	+			R	R				+	+			+		
0.7	RHUS AROMATICA																														
4.8	RHUS MICROPHYLLA																									+					
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA																		+		1		R	1							
57.0	XANTHOCEPHALUM SAROTHRAE	2	2	1	1	R			R						R	+				R			+	R	R	R		R	R	1	
4.8	YUCCA BACCATA																							+				+			
33.0	YUCCA ELATA	1	1						R				+								+						+			+	
6.5	YUCCA TORREYI			+																+	+		R								
16.5	GRASS SPP.																														
4.1	ARISTIDA SP.																												R		R
12.4	BOUTELOUA CURTIPENDULA																							1			2	1			
13.1	BOUTELOUA ERIOPODA						+									3		1					2	2			2		4	4	2
4.1	BOUTELOUA GRACILIS																														
3.1	BOUTELOUA HIRSUTA																													R	
0.3	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA											1	1	4														1			
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA						R	+				1	2						R	3											
6.9	MUHLENBERGIA PORTERI											3		+	+		2									1					R
2.4	MUHLENBERGIA SETIFOLIA																														
1.0	PANICUM OBTUSUM																														
10.0	SCLEROPOGON BREVIFOLIUS											3	3																		
3.1	SETARIA MACROSTACHYA																			R											
2.7	SPOROBOLUS CONTRACTUS																			+											
23.7	SPOROBOLUS CRYPTANDRUS	2	3				+										R												R	+	R
1.0	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS							4						+																	
6.9	SPOROBOLUS WRIGHTII							+																							
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS						R	R							1	R		1	1			R			2	2					R

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES																														
	QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	QUADRANT NO.	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	236	237	238	239	240	241	242	243	244
100.0	BARE GROUND	4	3	3	3	2	2	5	4	4	5	3	3	2	4	4	4	5	2	1	3	2	2	3	2	2	2	3	4	3	4
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA		1																		2	R	2	2							
0.3	AGAVE LECHEQUILLA																														
1.0	AGAVE PARRYI																														
0.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA											R	2	1	2	R												1	2	2	2
25.1	ATRIPLEX CANESCENS		R	R								+													+						R
6.5	BERBERIS TRIFOLIOLATA			+			+	+	+	+	+																				
12.7	DALEA FORMOSA	R																						R							
1.0	DALEA SCOPARIA																														
1.4	DASYLIRION WHEELERI																														
10.8	DYSSODIA ACEROSA		R		1																		+								
22.7	EPHEDRA SP.		R		R							+	+		+									+						R	
2.7	EUROTIA LANATA					+	R																								
25.8	FLOURENSIA CERNUA		R	2				+	R	R	R									3											
5.8	FOUQUIERIA SPLENDENS																														
3.4	KOEBERLINIA SPINOSA		+																			+		+	R						
2.1	KRAMERIA GLANDULOSA		R																		+		+								
56.7	LARREA TRIDENTATA			R				2			2						2	2	1	R			2			R					
2.4	NOLINA SP.				2																										
19.9	OPUNTIA SPP.				+												R								1						
23.7	PARTHENIUM INCANUM		R					R											2		R	+		1							
15.0	PROSOPIS GLANDULOSA	1				2			3	3		R					1	1									R	R	1		
0.7	RHUS AROMATICA																										+				
4.8	RHUS MICROPHYLLA																														
1.0	THELESPERMA LONGIPES																														R
4.8	VIGUIERA STENOLOBA																														
57.0	XANTHOCEPHALUM SAROTHRAE		R			R		1	R	R	R	R	2	1	2	2							R	1		R			+	R	
4.8	YUCCA BACCATA								+	+	+																				
33.0	YUCCA ELATA		+		R		+						+	R	R	R									1	R		R	R	R	R
6.5	YUCCA TORREYI					+																									
16.5	GRASS SPP.																														
4.1	ARISTIDA SP.	1			+																										
12.4	BOUTELOUA CURTIPENDULA	2	1		3														1					2							
13.1	BOUTELOUA ERIOPODA	1	1			4	4									1			1				4	2		2					
4.1	BOUTELOUA GRACILIS			R		1																									
7.1	BOUTELOUA HIRSUTA	R					1																								
8.3	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA																			5	2	4			4	2	2				
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA						R																R								
6.9	MUHLENBERGIA PORTERI																														
2.4	MUHLENBERGIA SETIFOLIA																													3	
1.0	PANICUM OBTUSUM																														
10.0	SCLEROPOGON BREVIFOLIUS			+																					2	2					
3.1	SETARIA MACROSTACHYA																		+												
2.7	SPOROBOLUS CONTRACTUS																														1
23.7	SPOROBOLUS CRYPTANDRUS	+										3	1	3	R	1			R									3	2	2	3
1.0	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS																														
6.9	SPOROBOLUS WRIGHTII																										2				
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																		1												
13.1	TRIDENS MUTICUS																														

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	QUADRANT SIZE / QUADRANT NO. 400 245	400 246	400 247	400 248	40 249	40 250	20 251	20 252	25 253	35 254	20 255	20 256	14 257	400 258	400 259
100.0	BARE GROUND	4	4	4	5	4	2	4	3	4	4	3	3	4	3	3
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA				+							3	2	2		
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA	2	3	2												1
25.1	ATRIPLEX CANESCENS															1
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA								1			1	1			
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI														+	
10.0	DYSSODIA ACEROSA				R	2				1	+					
22.7	EPHEDRA SP.	R		R	R	1							2			
2.7	EUROTIA LANATA															
25.8	FLOURENSIA CERNUA												1			
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA														+	
2.1	KRAMERIA GLANDULOSA					2	1									
56.7	LARREA TRIDENTATA				R			1	2						R	
2.4	NOLINA SP.									1						
19.9	OPUNTIA SPP.				+											
23.7	PARTHENIUM INCANUM				R					1	2			1	1	
15.0	PROSOPIS GLANDULOSA															1
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA					+				2						
1.0	THELESPERMA LONGIPES	R		+												
4.8	VIGUIERA STENOLOBA				R										R	
57.0	XANTHOCEPHALUM SAROTHRAE							1		1		1				
4.8	YUCCA BACCATA															
33.0	YUCCA ELATA	R	R	R											R	
6.5	YUCCA TORREYI				+											
16.5	GRASS SPP.							R								
4.1	ARISTIDA SP.					+			+	1						
12.4	BOUTELOUA CURTIPENDULA					2	1		1	1	2	2	1	2	1	
14.1	BOUTELOUA ERIOPODA					1	3	2	1				2		1	
4.1	BOUTELOUA GRACILIS							2	1						1	
1.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA						1		3	2	+	1	2	1		
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA															
6.9	MUHLENBERGIA PORTERI							1		+						
2.4	MUHLENBERGIA SETIFOLIA															
1.8	PANICUM OBTUSUM															
10.0	SCLEROPOGON BREVIFOLIUS							1	2	1			1			
3.1	SETARIA MACROSTACHYA														+	
2.7	SPOROBOLUS CONTRACTUS	1		R												
23.7	SPOROBOLUS CRYPTANDRUS	2	1	1		1										3
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII						+	1								
0.3	STIPA PRINGLEI								+							
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS			2		+								+		

ABS. FREQ.	SPECIES	QUADRANT SIZE / QUADRANT NO. 400 260	400 261	400 252	400 263	400 264	400 265	400 266	400 267	400 268	400 269	400 270	400 271	400 272	400 273	400 274
100.0	BARE GROUND	3	2	[illegible]	2	3	2	1	4	4	2	3	3	3	2	3
0.3	JUNIPERUS MONOSPERMA											+				
0.3	QUERCUS UNDULATA											+				
15.1	ACACIA CONSTRICTA	1								2						
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI					+										
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA											2				
25.1	ATRIPLEX CANESCENS												R			
6.5	BERBERIS TRIFOLIOLATA		+		+											
12.7	DALEA FORMOSA	+														
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI		+													
10.0	DYSSODIA ACEROSA													R		
22.7	EPHEDRA SP.	+				R						+				
2.7	EUROTIA LANATA															
25.8	FLOURENSIA CERNUA									R	2			2	1	
5.8	FOUQUIERIA SPLENDENS	+	+	+										R		
3.4	KOEBERLINIA SPINOSA				+											
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA	1		+	+	1			2					2	3	
2.4	NOLINA SP.					R										
19.9	OPUNTIA SPP.															
23.7	PARTHENIUM INCANUM	2	+	R		1				R				R		
15.0	PROSOPIS GLANDULOSA	+	+											+		1
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA											+				
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA	+	1	1												
57.0	XANTHOCEPHALUM SAROTHRAE			1	1	1			1			R		2		
4.8	YUCCA BACCATA		1													
33.0	YUCCA ELATA	R	1	+		R										R
6.5	YUCCA TORREYI			+										R		
16.5	GRASS SPP.															
4.1	ARISTIDA SP.											R				
12.4	BOUTELOUA CURTIPENDULA	2	1	2	3	1							2			
14.1	BOUTELOUA ERIOPODA	2	3	+		2										
4.1	BOUTELOUA GRACILIS		1													
1.1	BOUTELOUA HIRSUTA		1	+												
0.3	CHLORIS VIRGATA												R			
15.8	HILARIA MUTICA						3	3		+	1				2	
0.3	LYCURUS PHLEOIDES					2										
6.5	MUHLENBERGIA ARENACEA															
6.9	MUHLENBERGIA PORTERI								1							
2.4	MUHLENBERGIA SETIFOLIA		1		+	1									1	
1.8	PANICUM OBTUSUM							2								
10.0	SCLEROPOGON BREVIFOLIUS						1			+	3				R	
3.1	SETARIA MACROSTACHYA								1		R		R			
2.7	SPOROBOLUS CONTRACTUS											1	1			
23.7	SPOROBOLUS CRYPTANDRUS											2	2			2
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII	+	+		+				1							
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS			+					1	R				1		

APPENDIX D. (Continued)

Phytosociological Data Sequentially Listed by Quadrant Number.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	302	303	304
	QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	50	400
100.0	BARE GROUND	4	3	3	4	4	3	2	4	4	2	3	2	3	5	4	3	3	3	3	3	4	4	3	3	4	2	4	2
0.3	JUNIPERUS MONOSPERMA																												
0.3	QUERCUS UNDULATA																												
15.1	ACACIA CONSTRICTA								R	2															1				
0.3	AGAVE LECHEQUILLA																												
1.0	AGAVE PARRYI																												
0.7	ALOYSIA WRIGHTII																												
15.1	ARTEMISIA FILIFOLIA		1																2	R								1	
25.1	ATRIPLEX CANESCENS		+		R																					2			
6.5	BERBERIS TRIFOLIOLATA																							+					
12.7	DALEA FORMOSA																	1											
1.0	DALEA SCOPARIA																												
1.4	DASYLIRION WHEELERI																												
10.0	DYSSODIA ACEROSA												R	R										1	1				
22.7	EPHEDRA SP.																									+			
2.7	EUROTIA LANATA											R																	
25.8	FLOURENSIA CERNUA									1	2										2	R			R		2	2	
5.8	FOUQUIERIA SPLENDENS								R				+			R									R				
3.4	KOEBERLINIA SPINOSA																												
2.1	KRAMERIA GLANDULOSA																												
56.7	LARREA TRIDENTATA	+				2				1			1	1		R					3	R	R	+	1			1	
2.4	NOLINA SP.																	R						R					
19.0	OPUNTIA SPP.			+							R	R						R							R				
23.7	PARTHENIUM INCANUM								1							R		R								+			
15.0	PROSOPIS GLANDULOSA	2			2		2													1		R				2			
0.7	RHUS AROMATICA																												
4.8	RHUS MICROPHYLLA																								1				
1.0	THELESPERMA LONGIPES																												
4.8	VIGUIERA STENOLOBA																	1											
57.0	XANTHOCEPHALUM SAROTHRAE		1		1	1					1		1	1			R			1	1					1		+	
4.8	YUCCA BACCATA																												
33.0	YUCCA ELATA	R	R				R					R	+	R			+			1				+				1	
6.5	YUCCA TORREYI												R	R		+								+					
16.5	GRASS SPP.																											2	
4.1	ARISTIDA SP.					R																			1	+			
12.4	BOUTELOUA CURTIPENDULA								2				2	2				2					2	3					
13.1	BOUTELOUA ERIOPODA								1	1		3	2	1			1		2				2						
4.1	BOUTELOUA GRACILIS										2			3	1		2												
3.1	BOUTELOUA HIRSUTA												2				2		2										
0.3	CHLORIS VIRGATA																												
15.8	HILARIA MUTICA			1				R		1	2				1												1		2
0.3	LYCURUS PHLEOIDES																												
6.5	MUHLENBERGIA ARENACEA																							1					R
6.9	MUHLENBERGIA PORTERI																				1								
2.4	MUHLENBERGIA SETIFOLIA												2					2											
1.0	PANICUM OBTUSUM										R																		
10.0	SCLEROPOGON BREVIFOLIUS			3				4																			3		3
3.1	SETARIA MACROSTACHYA																									R	R		
2.7	SPOROBOLUS CONTRACTUS	+					1																						
23.7	SPOROBOLUS CRYPTANDRUS	1	R				2													2		2				R			
1.0	SPOROBOLUS FLEXUOSUS															+	R		R										
1.0	SPOROBOLUS GIGANTEUS																												
6.9	SPOROBOLUS WRIGHTII																								2				
0.3	STIPA PRINGLEI																												
0.3	TRICHACHNE CALIFORNICA																												
13.1	TRIDENS MUTICUS															1									1				

APPENDIX E.

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	400	30	400	400	400	60	400	400	400	400	400	400	400	400	50	10	400	400	400	40	400	400	400	400	400	400
	QUADRANT NO.	74	132	65	64	78	173	79	107	57	55	11	84	213	295	174	158	217	289	271	249	198	206	297	291	92	110
100.0	BARE GROUND	+	4	5	4	5	4	4	2	4	5	3	3	3	4	4	4	4	4	3	4	2	3	3	3	2	3
0.3	JUNIPERUS MONOSPERMA																										
0.3	QUERCUS UNDULATA																										
15.1	ACACIA CONSTRICTA																										+
0.3	AGAVE LECHEQUILLA																										
1.0	AGAVE PARRYI																										
0.7	ALOYSIA WRIGHTII																										
15.1	ARTEMISIA FILIFOLIA	R					+						+	R				R								+	
25.1	ATRIPLEX CANESCENS	+						+			R	1	R	+						R							R
6.5	BERBERIS TRIFOLIOLATA																					+		+			
12.7	DALEA FORMOSA	3	2	+	+																				1	2	+
1.0	DALEA SCOPARIA																										
1.4	DASYLIRION WHEELERI																										+
10.0	DYSSODIA ACEROSA																				2	1	1	1			
22.7	EPHEDRA SP.		1	R	R	R	1	1	R	+	R			+							1	+	R			R	
2.7	EUROTIA LANATA																										
25.8	FLOURENSIA CERNUA														R												
5.6	FOUQUIERIA SPLENDENS																		R								R
3.4	KOEBERLINIA SPINOSA																										
2.1	KRAMERIA GLANDULOSA																				2	2					
56.7	LARREA TRIDENTATA			R											R				R			+		+			+
2.4	NOLINA SP.																						2	R	R		
19.9	OPUNTIA SPP.																						+		R		2
23.7	PARTHENIUM INCANUM																		R						R		+
15.0	PROSOPIS GLANDULOSA								R	R	R	+	R	R	R												+
0.7	RHUS AROMATICA																										
4.8	RHUS MICROPHYLLA																				+						
1.0	THELESPERMA LONGIPES																										
4.8	VIGUIERA STENOLOBA																								1		
57.0	XANTHOCEPHALUM SAROTHRAE		1			2	2	1	+	1	+	+	1	R		2	1	2								+	
4.8	YUCCA BACCATA																										2
33.0	YUCCA ELATA	+		R			1		+		+		+			1		R				+	R	+		+	
6.5	YUCCA TORREYI					1													+					+			
16.5	GRASS SPP.																										
4.1	ARISTIDA SP.																				+		+				
12.4	BOUTELOUA CURTIPENDULA																			2	2	2	3	3	2	3	2
13.1	BOUTELOUA ERIOPODA																	1			1	2					
4.1	BOUTELOUA GRACILIS																									2	
3.1	BOUTELOUA HIRSUTA																										
0.3	CHLORIS VIRGATA																			R							
15.8	HILARIA MUTICA																										
0.3	LYCURUS PHLEOIDES																										
6.5	MUHLENBERGIA ARENACEA																							1			
6.9	MUHLENBERGIA PORTERI																										
2.4	MUHLENBERGIA SETIFOLIA																								2		
1.0	PANICUM OBTUSUM																										
10.0	SCLEROPOGON BREVIFOLIUS																										
3.1	SETARIA MACROSTACHYA																			R							
2.7	SPOROBOLUS CONTRACTUS																			1							
23.7	SPOROBOLUS CRYPTANDRUS	1	2	2	2	1	2	2	4	2	2	3	2	3	2	3	2	1		2	1						
1.0	SPOROBOLUS FLEXUOSUS																		+								
1.0	SPOROBOLUS GIGANTEUS																										
6.9	SPOROBOLUS WRIGHTII																										
0.3	STIPA PRINGLEI																										
0.3	TRICHACHNE CALIFORNICA																										
13.1	TRIDENS MUTICUS				1														1		+						

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 234

ABS. FREQ.	QUADRANT SIZE	400	400	40	400	400	400	400	400	400	400	400	400	400	400	400	400	20	20	400	400	400	400	400	400	400	400	400	400	400	400
	QUADRANT NO.	263	262	250	261	296	200	206	285	189	290	179	191	98	202	201	236	251	252	267	91	265	86	96	221	22	183	85	101	15	239
	SPECIES																														
100.0	BARE GROUND	2	3	2	2	4	2	2	3	4	3	2	4	3	3	2	2	4	3	3	2	2	4	1	1	2	2	2	2	2	2
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA									+							2														
0.3	AGAVE LECHEQUILLA																														
1.0	AGAVE PARRYI																														
0.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA																				R										
25.1	ATRIPLEX CANESCENS																									R			+		
6.8	BERBERIS TRIFOLIOLATA	+			+		1	+																							
12.7	DALEA FORMOSA																		1		2		2								
1.0	[illegible]SA SCOPARIA																														
1.4	D[illegible]LIRION WHEELERI				+																										
10.0	[illegible]SODIA ACEROSA											+	2			+			R		R	R									
22.7	EPHEDRA SP.									R											R										
2.7	EUROTIA LANATA						R	R	R						+	+															
25.8	FLOURENSIA CERNUA									R		+	+		R									2	3	2	2	2	2	2	
5.8	FOUQUIERIA SPLENDENS		+		+					R												+									
3.4	KOEBERLINIA SPINOSA	+																													
2.1	KRAMERIA GLANDULOSA			1													+														
56.7	LARREA TRIDENTATA	+	+			R	+			R		+	2	1	1	2	2	1	2	1	2	1	1		R	R	R	+			R
2.4	NOLINA SP.																														
19.9	OPUNTIA SPP.								R					R							R		R				+		R	R	
23.7	PARTHENIUM INCANUM		R		+					R																					
15.0	PROSOPIS GLANDULOSA				+		+					+	R	R										R							
0.7	RHUS AROMATICA																														
4.8	RHUS MICROPHYLLA																							R							
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA		1		1																										
57.0	XANTHOCEPHALUM SAROTHRAE	1	1				R				R		R	1		1	R	1		1	R	1	1								R
4.8	YUCCA BACCATA				1																		1								
33.0	YUCCA ELATA		+		1			+	R		+					+				R		+									R
6.5	YUCCA TORREYI		+										+							R		R									
16.5	GRASS SPP.																	R													
4.1	ARISTIDA SP.						R								R				+												
12.4	BOUTELOUA CURTIPENDULA	3	2	1	1	2													1	2	3	2	1								
13.1	BOUTELOUA ERIOPODA		+	3	3	2	4	4	3	1	1			3	2	4	4	2	1	1		2									2
4.1	BOUTELOUA GRACILIS				1						2							2	1	3	2										
3.1	BOUTELOUA HIRSUTA		+		1			1			2					R						2									
0.3	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA			1															3					5	5	4	1	3	1	4	2
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA							R				+	3				R										1				
6.9	MUHLENBERGIA PORTERI														R			1									3				
2.4	MUHLENBERGIA SETIFOLIA	+			1																	2									
1.0	PANICUM OBTUSUM																														
10.0	SCLEROPOGON BREVIFOLIUS																	1	2							1	3	2	4		2
3.1	SETARIA MACROSTACHYA												R																		
2.7	SPOROBOLUS CONTRACTUS												+																		
23.7	SPOROBOLUS CRYPTANDRUS						R								R	+															
1.0	SPOROBOLUS FLEXUOSUS										R																				
1.0	SPOROBOLUS GIGANTEUS											4																			
6.9	SPOROBOLUS WRIGHTII	+		+	+							+						1			1										
0.3	STIPA PRINGLEI																		+												
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS		+							1		R		1	R																

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES / QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	25	35	400	400	400	400	400	150	100	100	400	400	400
	QUADRANT NO.	238	265	277	281	87	304	223	266	240	288	47	195	204	89	187	181	178	253	254	49	258	262	260	264	126	127	124	241	215	276
100.0	BARE GROUND	4	2	3	2	2	2	2	1	2	5	3	3	3	3	3	5	4	4	4	3	3	4	3	3	5	4	4	3	2	3
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA							R					1	1	1	1	R	R			1		R	1							
0.3	AGAVE LECHEQUILLA																										1				
1.9	AGAVE PARRYI																								+	1		+			
0.7	ALOYSIA WRIGHTII																										+				
15.1	ARTEMISIA FILIFOLIA																												1	1	1
25.1	ATRIPLEX CANESCENS	+												R																	+
6.5	BERBERIS TRIFOLIOLATA												+								R							1			
12.7	DALEA FORMOSA														2						R			+		1		+			
1.0	DALEA SCOPARIA																														
1.4	DASYLIRION WHEELERI																					+						+			
10.0	DYSSODIA ACEROSA												1	R	2	R		R	1	+											
22.7	EPHEDRA SP.												R	R	+		+	R			R			+	R			+			
2.7	EUROTIA LANATA																														
25.8	FLOURENSIA CERNUA											+		R			+														
5.8	FOUQUIERIA SPLENDENS																	R					R	+			+				
3.4	KOEBERLINIA SPINOSA	R						+						+								+									
2.1	KRAMERIA GLANDULOSA													R																	
56.7	LARREA TRIDENTATA					R						+	1			R	R	R			R	R		1	1	+	1	1			
2.4	NOLINA SP.																		1						R			1			
19.9	OPUNTIA SPP.	1		+		R						+	R		R	+										+	R				
23.7	PARTHENIUM INCANUM							+						R		R	1	1	1	2	2	1	1	2	1	2	2	1			
15.0	PROSOPIS GLANDULOSA									R						+								+		+			R		
8.7	RHUS AROMATICA									+																		+			
4.8	RHUS MICROPHYLLA																		2									+			
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA												1									R		+		+	1	1			
57.0	XANTHOCEPHALUM SAROTHRAE												R	R		+			1						1	1	1	1		1	1
4.8	YUCCA BACCATA												+																		
33.0	YUCCA ELATA	+												+								R		R	R			+	R	R	R
6.5	YUCCA TORREYI																									R	+				
16.5	GRASS SPP.																									1	2	2			
4.1	ARISTIDA SP.																		1												
12.4	BOUTELOUA CURTIPENDULA												1	1	2				1	2	2	1	2	2	1						
13.1	BOUTELOUA ERIOPODA												2	1		3		+				1	1	2	2						
4.1	BOUTELOUA GRACILIS										1											1									
3.1	BOUTELOUA HIRSUTA																														
0.3	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA	4	3	1	[illegible]	5	2	4	3	2	1	5							2	+											
0.3	LYCURUS PHLEOIDES																								2						
6.5	MUHLENBERGIA ARENACEA						R											R													
6.9	MUHLENBERGIA PORTERI																		+												
2.4	MUHLENBERGIA SETIFOLIA																								1						
1.0	PANICUM OBTUSUM								2																						
10.0	SCLEROPOGON BREVIFOLIUS	2	1	3	4	2	3												1												
3.1	SETARIA MACROSTACHYA																					+									
2.7	SPOROBOLUS CONTRACTUS																														
23.7	SPOROBOLUS CRYPTANDRUS																	+											3	3	3
1.0	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS																														
6.9	SPOROBOLUS WRIGHTII									2														+							
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS														R		R														

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES																														
	QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	30	33	400	400	400	30	400	400	30	400	400	400	30
	QUADRANT NO.	30	29	10	297	203	274	259	293	20	62	63	117	111	112	114	77	72	136	138	2	209	279	141	212	32	139	118	6	71	140
100.0	BARE GROUND	4	2	2	2	4	3	3	3	4	4	4	5	5	5	4	5	4	4	4	4	5	4	5	5	4	5	5	4	5	4
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA																													+	
0.3	AGAVE LECHEQUILLA																														
1.0	AGAVE PARRYI																														
6.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA	1	1	2				1	R																	+					
25.1	ATRIPLEX CANESCENS	+	+	+				1													R										
6.5	BERBERIS TRIFOLIOLATA																					+			+						
12.7	DALEA FORMOSA					R					2	1	R	1	2	1															
1.0	DALEA SCOPARIA																														
1.4	DASYLIRION WHEELERI																														
18.0	DYSSODIA ACEROSA																														
22.7	EPHEDRA SP.																				R										
2.7	EUROTIA LANATA				+																										
25.8	FLOURENSIA CERNUA																+					+			R			+			
5.8	FOUQUIERIA SPLENDENS																														
3.4	KOEBERLINIA SPINOSA																														
2.1	KRAMERIA GLANDULOSA																														
56.7	LARREA TRIDENTATA									2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2	3
2.4	NOLINA SP.																														
19.9	OPUNTIA SPP.									R				+	R	R															+
23.7	PARTHENIUM INCANUM	R																+				R						+			
15.0	PROSOPIS GLANDULOSA	+		)	2	1	1	1	1	+	R					R	+	+						/				+			
9.7	RHUS AROMATICA																														
4.8	RHUS MICROPHYLLA																													R	
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA																														
57.8	XANTHOCEPHALUM SAROTHRAE	1		+	R				1	2	+	+							1	1	1	1	1	+	R	2	+				
4.8	YUCCA BACCATA																								+						
33.0	YUCCA ELATA	+	1				R		1		R															+					
6.5	YUCCA TORREYI				+																										
16.5	GRASS SPP.									+	+	R	R	+	+	+	+	+								+	+				
4.4	ARISTIDA SP.					1																	R								
12.4	BOUTELOUA CURTIPENDULA					?																									
13.1	BOUTELOUA ERIOPODA				4	1																									
4.1	BOUTELOUA GRACILIS				1																										
3.1	BOUTELOUA HIRSUTA					R																									
0.3	CHLORIS VIRGATA																														
15.0	HILARIA MUTICA																														
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA																														
6.9	MUHLENBERGIA PORTERI																														
2.4	MUHLENBERGIA SETIFOLIA																														
1.0	PANICUM OBTUSUM																														
10.0	SCLEROPOGON BREVIFOLIUS																														
3.1	SETARIA MACROSTACHYA																														
2.7	SPOROBOLUS CONTRACTUS																														
23.7	SPOROBOLUS CRYPTANDRUS	2	2	4		+	2	3	2																						
1.0	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS																														
6.9	SPOROBOLUS WRIGHTII																														
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS																														

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	QUADRANT SIZE	400	400	400	60	50	30	30	30	30	30	30	400	400	400	400	400	50	400	400	30	400	400	400	400	50	50	30	100	100
	QUADRANT NO.	17	99	12	151	131	137	150	149	142	143	160	267	70	43	44	115	166	25	186	167	196	197	220	19	175	176	145	129	125
	SPECIES																													
100.0	BARE GROUND	5	4	4	5	4	4	4	4	3	4	5	4	5	4	3	5	4	3	4	5	4		2	4	5	5	4	2	4
0.3	JUNIPERUS MONOSPERMA																													
0.3	QUERCUS UNDULATA																													
15.1	ACACIA CONSTRICTA																						+							1
0.3	AGAVE LECHEQUILLA																													
1.0	AGAVE PARRYI																													
0.7	ALOYSIA WRIGHTII																													+
15.1	ARTEMISIA FILIFOLIA																													
25.1	ATRIPLEX CANESCENS															R														
6.5	BERBERIS TRIFOLIOLATA																													
12.7	DALEA FORMOSA					1											+	1								+			R	+
1.0	DALEA SCOPARIA																													
1.4	DASYLIRION WHEELERI																													
10.0	DYSSODIA ACEROSA		1																											
22.7	EPHEDRA SP.																													+
2.7	EUROTIA LANATA																												1	
25.8	FLOURENSIA CERNUA									+						+					1								1	
5.8	FOUQUIERIA SPLENDENS																													1
3.4	KOEBERLINIA SPINOSA																													+
2.1	KRAMERIA GLANDULOSA																													
56.7	LARREA TRIDENTATA	2	2	2	2	2	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	2
2.4	MOLINA SP.																													
19.9	OPUNTIA SPP.		R							+				R	+	R			R										+	1
23.7	PARTHENIUM INCANUM									+	+				R		1	1	1	1	2	1	2	2	1	1	1	1	2	1
15.0	PROSOPIS GLANDULOSA		+												+					R		+	+		+			+	+	
0.7	RHUS AROMATICA																													
4.8	RHUS MICROPHYLLA																						+						+	
1.0	THELESPERMA LONGIPES																													
4.8	VIGUIERA STENOLOBA																												1	
57.0	XANTHOCEPHALUM SAROTHRAE	R	2			1	+	1	2	2	1		1		+			1	1	R	+	R	R		2	1	1	2	1	
4.8	YUCCA BACCATA													1											+					
83.0	YUCCA ELATA		R							2								1			2				+					
6.5	YUCCA TORREYI																									+				1
16.5	GRASS SPP.	2	2																											2
4.1	ARISTIDA SP.																													
12.4	BOUTELOUA CURTIPENDULA																							1						
13.1	BOUTELOUA ERIOPODA																							1						
4.1	BOUTELOUA GRACILIS																													
3.1	BOUTELOUA HIRSUTA																													
0.3	CHLORIS VIRGATA																													
15.8	HILARIA MUTICA															2														
0.3	LYCURUS PHLEOIDES																													
6.5	MUHLENBERGIA ARENACEA										2	1				1														
6.9	MUHLENBERGIA PORTERI												1		2					+			1							
2.4	MUHLENBERGIA SETIFOLIA																													
1.0	PANICUM OBTUSUM																													
10.0	SCLEROPOGON BREVIFOLIUS									1																				
3.1	SETARIA MACROSTACHYA												1											+						
2.7	SPOROBOLUS CONTRACTUS																													
23.7	SPOROBOLUS CRYPTANDRUS																							R						
1.0	SPOROBOLUS FLEXUOSUS																													
1.0	SPOROBOLUS GIGANTEUS																													
6.9	SPOROBOLUS WRIGHTII			2	1	2	1	2	1	1			1																	
0.3	STIPA PRINGLEI																													
0.3	TRICHACHNE CALIFORNICA																							1						
13.1	TRIDENS MUTICUS					1	1	R			1	R	1	1				1	2	1	1	2	2					+	+	

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	QUADRANT SIZE / SPECIES	50	400	400	50	50	400	30	400	400	50	30	400	400	30	100	100	400	400	400	100	350	400	300	60	400	400
	QUADRANT NO.	169	218	219	170	168	1	161	42	41	163	147	3	58	135	159	130	82	39	18	128	122	73	123	153	48	35
100.0	BARE GROUND	5	4	5	4	5	3	4	4	5	3	4	3	4	4	4	5	3	4	5	2	4	3	4	4	3	2
0.3	JUNIPERUS MONOSPERMA																										
0.7	QUERCUS UNDULATA																										
15.1	ACACIA CONSTRICTA																										
0.3	AGAVE LECHEQUILLA																										
1.0	AGAVE PARRYI																										
0.7	ALOYSIA WRIGHTII																										
15.1	ARTEMISIA FILIFOLIA																								2		
29.1	ATRIPLEX CANESCENS								R	R				R									R	+			
6.8	BERBERIS TRIFOLIOLATA																										
12.7	DALEA FORMOSA															+	1										
1.0	DALEA SCOPARIA																										
1.4	DASYLIRION WHEELERI																										
10.0	DYSSODIA ACEROSA										+																
22.7	EPHEDRA SP.																	R									
2.7	EUROTIA LANATA																				+						
25.8	FLOURENSIA CERNUA										+	+								1	1	1	2	2	2	1	2
5.8	FOUQUIERIA SPLENDENS																										
3.4	KOEBERLINIA SPINOSA																										
2.1	KRAMERIA GLANDULOSA																										
56.7	LARREA TRIDENTATA	2	2	2	2	2	3	2	2	2	2	2	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2
2.4	NOLINA SP.																										
19.9	OPUNTIA SPP.		R				R			P											1					+	R
23.7	PARTHENIUM INCANUM										2	1				+					2						
15.1	PROSOPIS GLANDULOSA	1	1	1	2	2	1	2	1	1	2	2	1	2	2	2	1	1	2	2	2	1	2	1	1		
0.7	RHUS AROMATICA																										
4.8	RHUS MICROPHYLLA										2									1							
1.0	THELESPERMA LONGIPES																										
4.8	VIGUIERA STENOLOBA																										
57.0	XANTHOCEPHALUM SAROTHRAE							+	+	R	+	2	1	1	2	2	1	2	2	2	1	+		1	+		R
4.8	YUCCA BACCATA																			R							
37.0	YUCCA ELATA						2				1		R					+	+					1	1		
8.5	YUCCA TORREYI																				1						
16.5	GRASS SPP.																	+	2		1	2		1	2		
4.1	ARISTIDA SP.																										
12.4	BOUTELOUA CURTIPENDULA																										
13.1	BOUTELOUA ERIOPODA																										
4.1	BOUTELOUA GRACILIS																										
3.1	BOUTELOUA HIRSUTA																										
0.3	CHLORIS VIRGATA																										
15.8	HILARIA MUTICA										1															2	2
0.3	LYCURUS PHLEOIDES																										
6.5	MUHLENBERGIA ARENACEA																						2				
6.9	MUHLENBERGIA PORTERI								+	2	3	2															
2.4	MUHLENBERGIA SETIFOLIA																										
1.0	PANICUM OBTUSUM																						2				
18.0	SCLEROPOGON BREVIFOLIUS																									1	2
3.1	SETARIA MACROSTACHYA																										
2.7	SPOROBOLUS CONTRACTUS																										
23.7	SPOROBOLUS CRYPTANDRUS													+	1	2	2										
1.0	SPOROBOLUS FLEXUOSUS																										
1.0	SPOROBOLUS GIGANTEUS																										
6.9	SPOROBOLUS WRIGHTII																										
0.3	STIPA PRINGLEI																										
0.3	TRICHACHNE CALIFORNICA																										
13.1	TRIDENS MUTICUS							2				+															

APPENDIX E. *(Continued)*

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	QUADRANT SIZE	400	400	400	400	30	400	400	400	30	400	400	400	400	400	400	20	20	400	14	400	400	400	400	400	400	400	400	400	400	400
	QUADRANT NO.	88	273	95	294	146	76	188	33	148	272	187	94	90	93	237	256	255	199	257	222	97	180	268	46	45	21	193	177	194	4
	SPECIES																														
100.0	BARE GROUND	3	2	5	3	5	4	3	3	4	3	5	5	4	4	3	3	3	4	4	3	+	4	4	4	5	4	3	4	4	4
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA											+	2	2	[illegible]	2	2	3	2	2	2	2	1	2	2	2	2	2	[illegible]	2	2
0.3	AGAVE LECHEQUILLA																														
1.0	AGAVE PARRYI																														
0.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA																														
25.1	ATRIPLEX CANESCENS							+															+								
6.5	BERBERIS TRIFOLIOLATA																		+						+	+				R	
12.7	DALEA FORMOSA												+		2	R	1	1	+												
1.0	DALEA SCOPARIA																									R					
1.4	DASYLIRION WHEELERI																														
10.7	DYSSODIA ACEROSA										R		+	+					+									+	R	1	
22.7	EPHEDRA SP.											+	+	+		+			R							R		R		R	
2.7	EUROTIA LANATA																														
25.8	FLOURENSIA CERNUA	1	1	2	2	1	2	1	1	1	2	1					1					+	+	R				+	1	+	
5.8	FOUQUIERIA SPLENDENS										R	+														R		+			
3.4	KOEBERLINIA SPINOSA											+				+							+					+			
2.1	KRAMERIA GLANDULOSA																				+										
56.7	LARREA TRIDENTATA	2	3	2	3	2	2	2	3	2	2	1										+	+		+	+	1	1	1	1	2
2.4	NOLINA SP.											2																			
19.9	OPUNTIA SPP.							+						R					R			+				+		R	+	+	R
23.7	PARTHENIUM INCANUM								1	1	R	R		+		1			1	1	R	1	1	R	+	+		R	+	R	
15.0	PROSOPIS GLANDULOSA			R			+	+			+												+			R	R		+		
0.7	RHUS AROMATICA																														
4.8	RHUS MICROPHYLLA																														
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA																													R	
57.4	XANTHOCEPHALUM SAROTHRAE			+	1					1	2					1		1	R			1	R		+	+	+		R	+	
4.8	YUCCA BACCATA																		+												1
33.0	YUCCA ELATA														+								R			R					
6.5	YUCCA TORREYI										R																			R	
16.5	GRASS SPP.												+		+											1					
4.1	ARISTIDA SP.																														
12.4	BOUTELOUA CURTIPENDULA													+		2	1	2	1	2											
13.1	BOUTELOUA ERIOPODA															2	2													2	
4.1	BOUTELOUA GRACILIS																														
3.1	BOUTELOUA HIRSUTA																					1									
0.3	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA		2	+													2	1	1	1	2			+							
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA								1	2																					
6.9	MUHLENBERGIA PORTERI				1	1	1	2	2	1																					
2.4	MUHLENBERGIA SETIFOLIA		1																												
1.0	PANICUM OBTUSUM																														
10.0	SCLEROPOGON BREVIFOLIUS	3	R														1					2		+							
3.1	SETARIA MACROSTACHYA																														
2.7	SPOROBOLUS CONTRACTUS																														
23.7	SPOROBOLUS CRYPTANDRUS							R																							
1.0	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS																														
6.9	SPOROBOLUS WRIGHTII																														
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS										1									+		1		R				R			

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES	400 5	400 298	35 165	400 283	75 164	400 302	46 154	400 269	400 16	400 184	400 34	400 50	400 75	400 205	400 104	400 284	50 152	50 303	400 7	400 192	400 185	30 162	30 134	400 46	30 144	400 210	400 211	400 113	50 171	400 102
	QUADRANT SIZE / QUADRANT NO.																														
108.0	BARE GROUND	4	3	4	4	4	2	3	2	1	2	2	3	3	3	3	2	4	4	2	2	2	3	4	4	4	4	4	4	5	4
0.3	JUNIPERUS MONOSPERMA																														
0.3	QUERCUS UNDULATA																														
15.1	ACACIA CONSTRICTA	2	1	2	2	1																									
0.3	AGAVE LECHEQUILLA																														
1.0	AGAVE PARRYI																														
0.7	ALOYSIA WRIGHTII																														
15.1	ARTEMISIA FILIFOLIA													+				1	1												
25.1	ATRIPLEX CANESCENS										+	R	1	1	R	R				R	+	+		+	R						
6.5	BERBERIS TRIFOLIOLATA														+												+	+			
12.7	DALEA FORMOSA																												1		
1.0	DALEA SCOPARIA																														
1.4	DASYLIRION WHEELERI																														
10.6	DYSSODIA ACEROSA		1																												
22.7	EPHEDRA SP.	P		+																	+								+	+	+
2.7	EUROTIA LANATA																														
25.8	FLOURENSIA CERNUA		R	+	1		2	2	2	3	3	4	2	2	2	2	2	2	2	3	3	2	1				R	R			
5.8	FOUQUIERIA SPLENDENS		R																												
3.4	KOEBERLINIA SPINOSA																														
2.1	KRAMERIA GLANDULOSA																														
56.7	LARREA TRIDENTATA	1	1	2	1	2					+	R	R		R			1	1	2	1	R	1	1	1	1					
2.4	NOLINA SP.																														
19.9	OPUNTIA SPP.	R	R								+	R	R			R	R												+		
23.7	PARTHENIUM INCANUM	2																								1			R		
15.0	PROSOPIS GLANDULOSA									1	1	R	R	+		R					R	1	1	3	2	2	3	3	+	2	+
0.7	RHUS AROMATICA																														
4.8	RHUS MICROPHYLLA		1			1				R																					
1.0	THELESPERMA LONGIPES																														
4.8	VIGUIERA STENOLOBA																				1										
57.0	XANTHOCEPHALUM SAROTHRAE			1		R											1	+	+					1	2	2	R	R	2	2	2
4.8	YUCCA BACCATA	R																									+	+			
33.0	YUCCA ELATA										+		R	R				1	1		+				+						+
6.5	YUCCA TORREYI																				+								+		
16.5	GRASS SPP.					2								2				2	2	4					2	+			+		
4.1	ARISTIDA SP.		1																												
12.4	BOUTELOUA CURTIPENDULA																														
13.1	BOUTELOUA ERIOPODA				1			2																							
4.1	BOUTELOUA GRACILIS														P		2														
3.1	BOUTELOUA HIRSUTA																														
0.7	CHLORIS VIRGATA																														
15.8	HILARIA MUTICA				1	1	1	3	1		1	5	2			3	2					4									
0.3	LYCURUS PHLEOIDES																														
6.5	MUHLENBERGIA ARENACEA			1							2					R							2								
6.0	MUHLENBERGIA PORTERI																					+	3								
2.4	MUHLENBERGIA SETIFOLIA																														
1.0	PANICUM OBTUSUM																R														
10.0	SCLEROPOGON BREVIFOLIUS					1	3	R	3		3				3	1															
3.1	SETARIA MACROSTACHYA						R	1	P																						
2.7	SPOROBOLUS CONTRACTUS									4																					
23.7	SPOROBOLUS CRYPTANDRUS					1																								+	
1.3	SPOROBOLUS FLEXUOSUS																														
1.0	SPOROBOLUS GIGANTEUS																					+									
6.9	SPOROBOLUS WRIGHTII		2					2					1																		
0.3	STIPA PRINGLEI																														
0.3	TRICHACHNE CALIFORNICA																														
13.1	TRIDENS MUTICUS		1	1																											

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	SPECIES \ QUADRANT SIZE	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	QUADRANT NO.	103	116	278	66	104	105	8	9	54	83	80	53	81	59	39
100.0	BARE GROUND	4	4	4	5	5	4	5	5	5	4	4	4	4	4	4
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA															
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA													R		
25.1	ATRIPLEX CANESCENS		+	R	+	+	+	R	R	+	R	+	+	+	1	1
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA															
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI															
10.0	DYSSODIA ACEROSA															
22.7	EPHEDRA SP.												R	R	+	+
2.7	EUROTIA LANATA															
25.6	FLOURENSIA CERNUA															
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA		R													
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.															
23.7	PARTHENIUM INCANUM															
15.0	PROSOPIS GLANDULOSA	+	2	2	2	2	2	2	2	2	2	2	2	2	2	2
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA															
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE	2	1	1	1	1	1	+	R	1	1	1	2	1	2	1
4.8	YUCCA BACCATA															
33.0	YUCCA ELATA	+			+	+	+	+	+	+	+	+	1	+		
6.5	YUCCA TORREYI															
16.5	GRASS SPP.									+	+	R	R	+		
4.1	ARISTIDA SP.															
12.4	BOUTELOUA CURTIPENDULA															
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA															
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA															
6.9	MUHLENBERGIA PORTERI															
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
10.0	SCLEROPOGON BREVIFOLIUS															
3.1	SETARIA MACROSTACHYA															
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS															
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII															
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS															

ABS. FREQ.	SPECIES \ QUADRANT SIZE	40	400	400	400	400	400	100	400	400	400	50	50	400	50	400
	QUADRANT NO.	133	60	299	68	14	67	121	51	52	23	155	156	56	157	24
100.0	BARE GROUND	5	5	4	4	3	2	5	4	4	3	4	4	4	4	4
0.3	JUNIPERUS MONOSPERMA															
0.3	QUERCUS UNDULATA															
15.1	ACACIA CONSTRICTA															
0.3	AGAVE LECHEQUILLA															
1.0	AGAVE PARRYI															
0.7	ALOYSIA WRIGHTII															
15.1	ARTEMISIA FILIFOLIA													+		
25.1	ATRIPLEX CANESCENS	2	1	2	+	2	2	2	1	+	+	1	1	+	+	
6.5	BERBERIS TRIFOLIOLATA															
12.7	DALEA FORMOSA															
1.0	DALEA SCOPARIA															
1.4	DASYLIRION WHEELERI															
10.0	DYSSODIA ACEROSA															
22.7	EPHEDRA SP.	+	+	+	1											
2.7	EUROTIA LANATA															
25.6	FLOURENSIA CERNUA															
5.8	FOUQUIERIA SPLENDENS															
3.4	KOEBERLINIA SPINOSA															
2.1	KRAMERIA GLANDULOSA															
56.7	LARREA TRIDENTATA					+										
2.4	NOLINA SP.															
19.9	OPUNTIA SPP.															
23.7	PARTHENIUM INCANUM			+												
15.0	PROSOPIS GLANDULOSA	1	2	2	2	2	2		2	2	3	3	2	2	2	2
0.7	RHUS AROMATICA															
4.8	RHUS MICROPHYLLA															
1.0	THELESPERMA LONGIPES															
4.8	VIGUIERA STENOLOBA															
57.0	XANTHOCEPHALUM SAROTHRAE	1	1	1		+	1	+	1	1	+	1	2	1	2	2
4.8	YUCCA BACCATA										R					
33.0	YUCCA ELATA				R	2			+	+				+		
6.5	YUCCA TORREYI					R										
16.5	GRASS SPP.		+					R								
4.1	ARISTIDA SP.			+												
12.4	BOUTELOUA CURTIPENDULA															
13.1	BOUTELOUA ERIOPODA															
4.1	BOUTELOUA GRACILIS															
3.1	BOUTELOUA HIRSUTA															
0.3	CHLORIS VIRGATA															
15.8	HILARIA MUTICA															
0.3	LYCURUS PHLEOIDES															
6.5	MUHLENBERGIA ARENACEA															
6.9	MUHLENBERGIA PORTERI															
2.4	MUHLENBERGIA SETIFOLIA															
1.0	PANICUM OBTUSUM															
10.0	SCLEROPOGON BREVIFOLIUS															
3.1	SETARIA MACROSTACHYA			R												
2.7	SPOROBOLUS CONTRACTUS															
23.7	SPOROBOLUS CRYPTANDRUS			R					1	1	2	1	2	2	2	2
1.0	SPOROBOLUS FLEXUOSUS															
1.0	SPOROBOLUS GIGANTEUS															
6.9	SPOROBOLUS WRIGHTII															
0.3	STIPA PRINGLEI															
0.3	TRICHACHNE CALIFORNICA															
13.1	TRIDENS MUTICUS															

APPENDIX E. (Continued)

Phytosociological Data Arranged by Plant Community.

NO. OF SPECIES - 56
NO. OF QUADRANTS - 294

ABS. FREQ.	QUADRANT SIZE	50	400	400	400	400	400	400	200	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	QUADRANT NO.	172	275	280	106	108	109	119	120	31	30	37	270	27	26	214	216	243	247	245	244	28	246	292	242	36	61	13	190	248
	SPECIES																													
100.0	BARE GROUND	5	4	3	4	4	4	5	5	3	3	4	3	3	2	3	4	3	4	4	4	4	4	3	4	4	5	5	5	5
0.3	JUNIPERUS MONOSPERMA												+																	
0.3	QUERCUS UNDULATA												+																	
1.1	ACACIA CONSTRICTA																												+	+
0.3	AGAVE LECHEQUILLA																													
1.0	AGAVE PARRYI																													
0.7	ALOYSIA WRIGHTII																													
15.1	ARTEMISIA FILIFOLIA				1	1	1	1	1	2	2	1	2	2	2	2	2	2	2	2	2	2	3	2	2	2				
25.1	ATRIPLEX CANESCENS				+	+	+	1		+	+	R									R						+	R		
6.5	BERBERIS TRIFOLIOLATA																												+	
12.7	DALEA FORMOSA																													
1.0	DALEA SCOPARIA									2	1																			
1.4	DASYLIRION WHEELERI																													
10.0	DYSSODIA ACEROSA																													R
22.7	EPHEDRA SP.						R	+				R	+	R	R	+	+	R	R	R						+	+		+	R
2.7	EUROTIA LANATA																													
25.8	FLOURENSIA CERNUA																											+		
5.8	FOUQUIERIA SPLENDENS																													
3.4	KOEBERLINIA SPINOSA																													
2.1	KRAMERIA GLANDULOSA																													
56.7	LARREA TRIDENTATA		+									R															+	R	+	R
2.4	NOLINA SP.																													
19.9	OPUNTIA SPP.													R																+
23.7	PARTHENIUM INCANUM																													R
15.0	PROSOPIS GLANDULOSA	2	2	2	2	2	2	2	+			R													1	1	1	1		
0.7	RHUS AROMATICA																													
4.8	RHUS MICROPHYLLA												+																	
1.0	THELESPERMA LONGIPES																		+	R	R									
4.8	VIGUIERA STENOLOBA																												+	R
57.0	XANTHOCEPHALUM SAROTHRAE	2			2	1	1	1	+		R	2	R	2	1	2	2	R							+	1		R		
4.8	YUCCA BACCATA																													
33.0	YUCCA ELATA		R	R	+	+	+	1	2	+	+			1	+	+	R	R	R	R	R	1	R		R	+				
0.5	YUCCA TORREYI																													+
16.5	GRASS SPP.				+	+	+																			1	R	+		
4.1	ARISTIDA SP.												R																	
12.4	BOUTELOUA CURTIPENDULA																													
13.1	BOUTELOUA ERIOPODA																							2						
4.1	BOUTELOUA GRACILIS																													
3.1	BOUTELOUA HIRSUTA																							2						
0.3	CHLORIS VIRGATA																													
15.8	HILARIA MUTICA																													
0.3	LYCURUS PHLEOIDES																													
6.5	MUHLENBERGIA ARENACEA																												R	
6.9	MUHLENBERGIA PORTERI																													
2.4	MUHLENBERGIA SETIFOLIA																	3												
1.0	PANICUM OBTUSUM																													
10.0	SCLEROPOGON BREVIFOLIUS																													
3.1	SETARIA MACROSTACHYA																													
2.7	SPOROBOLUS CONTRACTUS		+	1									1						R	1	1									
23.7	SPOROBOLUS CRYPTANDRUS	2	1	2						2	2	1	2	2	2	1	R	2	1	2	3	2	1		2					
1.0	SPOROBOLUS FLEXUOSUS																							R						
1.0	SPOROBOLUS GIGANTEUS																													
6.9	SPOROBOLUS WRIGHTII																													
0.3	STIPA PRINGLEI																													
0.3	TRICHACHNE CALIFORNICA																													
13.1	TRIDENS MUTICUS	1																	2										1	

APPENDIX F

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grassland (summary of all grassland communities)

MAP SYMBOL: 10

QUADRANTS:

11	65	87	158	198	217	249	265	285	295
47	74	92	173	200	223	250	266	288	296
55	78	107	174	206	238	261	271	289	297
57	79	110	179	208	239	262	277	290	298
64	84	132	189	213	240	263	281	291	304

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	3	+	6.25	1.1
Artemisia filifolia	6	R	12.5	2.3
Atriplex canescens	9	R	18.75	3.4
Berberis trifoliolata	6	+	12.5	2.3
Dalea formosa	7	2	14.6	2.7
Dasylirion Wheeleri	2	+	4.2	0.8
Dyssodia acerosa	4	1	8.3	1.5
Ephedra sp.	15	R	31.2	5.7
Eurotia lanata	3	R	6.2	1.1
Flourensia cernua	4	R	8.3	1.5
Fouquieria splendens	5	R	10.4	1.9
Koeberlinia spinosa	3	R	6.2	1.1
Krameria glandulosa	3	2	6.2	1.1
Larrea tridentata	15	R	31.2	5.7
Nolina sp.	3	1	6.3	1.1
Opuntia spp.	8	R	16.7	3.0
Parthenium incanum	7	R	14.6	2.6
Prosopis glandulosa	12	R	25.0	4.5

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Rhus aromatica	1	+	2.1	0.4
Rhus microphylla	1	+	2.1	0.4
Viguiera stenoloba	3	1	6.2	1.1
Xanthocephalum Sarothrae	19	1	39.6	7.1
Yucca baccata	2	2	4.2	0.8
Yucca elata	19	R	39.6	7.1
Yucca Torreyi	4	+	8.3	1.5
Grasses				
Aristida sp.	3	R	6.2	1.1
Bouteloua curtipendula	13	2	27.1	4.9
Bouteloua eriopoda	13	2	27.1	4.9
Bouteloua gracilis	4	2	8.3	1.5
Bouteloua hirsuta	4	1	8.3	1.5
Chloris virgata	1	R	2.1	0.4
Hilaria mutica	13	3	27.1	4.9
Muhlenbergia arenacea	4	R	8.3	1.5
Muhlenbergia setifolia	3	1	6.2	1.1
Panicum obtusum	1	2	2.1	0.4
Scleropogon brevifolius	7	2	14.6	2.6
Setaria macrostachya	1	R	2.1	0.4
Sporobolus contractus	1	1	2.1	0.4
Sporobolus cryptandrus	20	2	40.0	7.5
Sporobolus flexuosus	2	R	4.2	0.8
Sporobolus giganteus	1	4	2.1	0.4
Sporobolus Wrightii	5	+	10.4	1.9
Tridens muticus	6	1	12.5	2.3

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Bouteloua eriopoda - Bouteloua curtipendula

COMMUNITY SYMBOL: 10a

QUADRANTS: 189 200 208 250 261 285 290 296

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	1	+	12.5	1.9
Berberis trifoliolata	3	R	37.5	5.8
Dasylirion Wheeleri	1	+	12.5	1.9
Ephedra sp.	1	R	12.5	1.9
Eurotia lanata	3	R	37.5	5.8
Flourensia cernua	1	R	12.5	1.9
Krameria glandulosa	1	2	12.5	1.9
Larrea tridentata	3	R	37.5	5.8
Opuntia spp.	1	R	12.5	1.9
Parthenium incanum	2	R	25.0	3.8
Prosopis glandulosa	2	+	25.0	3.8
Viguiera stenoloba	1	1	12.5	1.9
Xanthocephalum Sarothrae	2	R	25.0	3.8
Yucca baccata	1	1	12.5	1.9
Yucca elata	4	R	50.0	7.7
Grasses				
Aristida sp.	1	R	12.5	1.9
Bouteloua curtipendula	3	2	37.5	5.8
Bouteloua eriopoda	8	3	100.0	15.4
Bouteloua gracilis	2	2	25.0	3.8
Bouteloua hirsuta	3	1	37.5	5.8
Hilaria mutica	1	1	12.5	1.9

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Muhlenbergia arenacea	1	R	12.5	1.9
Muhlenbergia setifolia	1	1	12.5	1.9
Sporobolus cryptandrus	1	R	12.5	1.9
Sporobolus flexuosus	1	R	12.5	1.9
Sporobolus Wrightii	2	+	25.0	3.8
Tridens muticus	1	1	12.5	1.9

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Bouteloua curtipendula - Bouteloua uniflora

COMMUNITY SYMBOL: 10b

QUADRANTS: 92 110 198 206 249 262 263 289 291 297

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	1	+	10.0	1.3
Artemisia filifolia	1	+	10.0	1.3
Atriplex canescens	1	R	10.0	1.3
Berberis trifoliolata	3	+	30.0	3.9
Dalea formosa	3	1	30.0	3.9
Dasylirion Wheeleri	1	+	10.0	1.3
Dyssodia acerosa	4	1	40.0	5.3
Ephedra sp.	4	1	40.0	5.3
Fouquieria splendens	3	R	30.0	3.9
Koeberlinia spinosa	1	+	10.0	1.3
Krameria glandulosa	2	2	20.0	2.6
Larrea tridentata	6	+	60.0	7.9
Nolina sp.	3	1	30.0	3.9
Opuntia spp.	3	1	30.0	3.9
Parthenium incanum	4	R	40.0	5.3
Prosopis glandulosa	1	+	10.0	1.3
Rhus microphylla	1	+	10.0	1.3
Viguiera stenoloba	2	1	20.0	2.6
Xanthocephalum Sarothrae	3	1	30.0	3.9
Yucca baccata	1	2	10.0	1.3
Yucca Torreyi	3	+	30.0	3.9

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Grasses				
Aristida sp.	2	+	20.0	2.6
Bouteloua curtipendula	9	3	90.0	11.8
Bouteloua eriopoda	3	1	30.0	3.9
Bouteloua gracilis	1	2	10.0	1.3
Bouteloua hirsuta	1	+	10.0	1.3
Muhlenbergia arenacea	1	1	10.0	1.3
Muhlenbergia setifolia	2	1	20.0	2.6
Sporobolus cryptandrus	1	1	10.0	1.3
Sporobolus flexuosus	1	+	10.0	1.3
Sporobolus Wrightii	1	+	10.0	1.3
Tridens muticus	3	R	30.0	3.9

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Scleropogon brevifolius - Hilaria mutica

COMMUNITY SYMBOL: 10c

QUADRANTS: 47 223 239 240 265 266 277 281 288 304
87 238

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	1	R	8.3	2.4
Atriplex canescens	1	+	8.3	2.4
Flourensia cernua	1	+	8.3	2.4
Koeberlinia spinosa	2	+	16.7	4.8
Larrea tridentata	3	R	25.0	7.1
Opuntia spp.	4	R	33.3	9.5
Parthenium incanum	1	+	8.3	2.4
Prosopis glandulosa	1	R	8.3	2.4
Rhus aromatica	1	+	8.3	2.4
Xanthocephalum Sarothrae	1	R	8.3	2.4
Yucca elata	2	1	16.7	4.8
Grasses				
Bouteloua eriopoda	1	2	8.3	2.4
Bouteloua gracilis	1	1	8.3	2.4
Hilaria mutica	12	3	100.0	28.6
Muhlenbergia arenacea	1	R	8.3	2.4
Panicum obtusum	1	2	8.3	2.4
Scleropogon brevifolius	7	2	58.3	16.7
Sporobolus Wrightii	1	2	8.3	2.4

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Sporobolus cryptandrus - Sporobolus flexuosus

COMMUNITY SYMBOL: 10d

QUADRANTS:									
11	57	65	78	84	132	173	213	271	295
55	64	74	79	107	158	174	217		

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	5	R	22.8	6.1
Atriplex canescens	7	R	38.9	8.5
Dalea formosa	4	1	22.2	4.9
Ephedra sp.	10	1	55.6	12.2
Flourensia cernua	1	R	5.6	1.2
Larrea tridentata	2	R	11.1	2.4
Prosopis glandulosa	7	R	38.9	8.5
Xanthocephalum Sarothrae	13	1	72.2	15.9
Yucca elata	8	1	44.4	9.8
Yucca Torreyi	1	1	5.6	1.2
Grasses				
Bouteloua curtipendula	1	2	5.6	1.2
Bouteloua eriopoda	1	1	5.6	1.2
Chloris virgata	1	R	5.6	1.2
Setaria macrostachya	1	R	5.6	1.2
Sporobolus contractus	1	1	5.6	1.2
Sporobolus cryptandrus	16	2	100.0	22.0
Tridens muticus	1	1	5.6	1.2

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grass - Larrea tridentata

MAP SYMBOL: 11

QUADRANTS: 86 98 191 201 202 236 251 252 286 287 91

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	1	2	9.1	1.1
Artemisia filifolia	1	R	9.1	1.1
Dalea formosa	3	2	27.3	3.4
Dyssodia acerosa	6	R	54.5	6.8
Ephedra sp.	1	R	9.1	1.1
Eurotia lanata	2	+	18.2	2.3
Flourensia cernua	2	R	18.2	2.3
Fouquieria splendens	1	+	9.1	1.1
Krameria glandulosa	1	+	9.1	1.1
Larrea tridentata	11	2	100.0	12.5
Opuntia spp.	3	R	27.3	3.4
Prosopis glandulosa	2	R	18.2	2.3
Xanthocephalum Sarothrae	9	1	81.8	10.2
Yucca baccata	1	1	9.1	1.1
Yucca elata	3	+	27.3	3.4
Yucca Torreyi	3	R	27.3	3.4
Grasses				
Aristida sp.	2	R	18.2	2.3
Bouteloua curtipendula	5	2	45.5	5.6
Bouteloua eriopoda	8	2	72.7	9 [illegible]
Bouteloua gracilis	4	2	36.4	4.5
Bouteloua hirsuta	2	1	18.2	2.3

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Hilaria mutica	1	3	9.1	1.1
Muhlenbergia arenacea	2	2	18.2	2.3
Muhlenbergia Porteri	2	1	18.2	2.3
Muhlenbergia setifolia	1	2	9.1	1.1
Scleropogon brevifolius	2	2	18.2	2.3
Setaria macrostachya	1	R	9.1	1.1
Sporobolus contractus	1	+	9.1	1.1
Sporobolus cryptandrus	2	R	18.2	2.3
Sporobolus Wrightii	2	1	18.2	2.3
Stipa Pringlei	1	+	9.1	1.[illegible]
Tridens muticus	2	1	18.2	2.4
Grass spp.	1	R	9.1	1.1

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grass - Flourensia cernua

MAP SYMBOL: 12

QUADRANTS: 15 22 85 96 101 183 221

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Atriplex canescens	2	R	28.6	6.5
Flourensia cernua	7	2	100.0	22.6
Larrea tridentata	4	R	57.1	12.9
Opuntia spp.	3	R	42.9	9.7
Prosopis glandulosa	1	R	14.3	3.2
Rhus microphylla	1	R	14.3	3.2
Grasses				
Hilaria mutica	7	3	100.0	22.6
Muhlenbergia arenacea	1	1	14.3	3.2
Muhlenbergia Porteri	1	3	14.3	3.2
Scleropogon brevifolius	4	2	57.1	12.9

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grass - Acacia constricta

MAP SYMBOL: 13

QUADRANTS: 89 187 195 204

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	4	1	100.0	10.5
Atriplex canescens	1	R	25.0	2.6
Berberis trifoliolata	1	+	25.0	2.6
Dalea formosa	1	2	25.0	2.6
Dyssodia acerosa	4	1	100.0	10.5
Ephedra sp.	3	R	75.0	7.9
Flourensia cernua	1	R	25.0	2.6
Koeberlinia spinosa	1	+	25.0	2.6
Krameria glandulosa	1	R	25.0	2.6
Larrea tridentata	2	1	50.0	5.3
Opuntia spp.	3	R	75.0	7.9
Parthenium incanum	2	R	50.0	5.3
Prosopis glandulosa	1	+	25.0	2.6
Viguiera stenoloba	1	1	25.0	2.6
Xanthocephalum Sarothrae	3	R	75.0	7.9
Yucca baccata	1	+	25.0	2.6
Yucca elata	1	+	25.0	2.6
Grasses				
Bouteloua curtipendula	3	1	75.0	7.9
Bouteloua eriopoda	3	2	75.0	7.9
Tridens muticus	1	R	25.0	2.6

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grass - Artemisia filifolia

MAP SYMBOL: 14

QUADRANTS: 10 29 38 215 241 276

SPECIES	NO OF. QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	6	1	100.0	22.2
Atriplex canescens	4	+	66.7	14.8
Parthenium incanum	1	R	16.7	3.7
Prosopis glandulosa	3	R	50.0	11.1
Xanthocephalum Sarothrae	4	1	66.7	14.8
Yucca elata	5	R	83.3	18.5
Grasses				
Sporobolus cryptandrus	4	3	66.7	14.8

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grass - Prosopis glandulosa

MAP SYMBOL: 15

QUADRANTS: 203 207 259 274 293

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	2	1	40.0	8.0
Atriplex canescens	1	1	20.0	4.0
Dalea formosa	1	R	20.0	4.0
Eurotia lanata	1	+	20.0	4.0
Prosopis glandulosa	5	1	100.0	20.0
Xanthocephalum Sarothrae	2	R	40.0	8.0
Yucca elata	2	R	40.0	8.0
Yucca Torreyi	1	+	20.0	4.0
Grasses				
Aristida sp.	1	1	20.0	4.0
Bouteloua curtipendula	1	2	20.0	4.0
Bouteloua eriopoda	2	2	40.0	8.0
Bouteloua gracilis	1	1	20.0	4.0
Bouteloua hirsuta	1	R	20.0	4.0
Sporobolus cryptandrus	4	2	80.0	16.0

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Grass - Parthenium incanum

MAP SYMBOL: 16

QUADRANTS: 49 126 178 181 253 254 258 260 264 282
124 127

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	5	1	41.7	4.6
Agave lechequilla	1	1	8.3	0.9
Agave Parryi	3	1	25.0	2.8
Aloysia Wrightii	1	+	8.3	0.9
Berberis trifoliolata	2	1	16.7	1.9
Dalea formosa	4	R	33.3	3.7
Dasylirion Wheeleri	2	+	16.7	1.9
Dyssodia acerosa	3	R	25.0	2.8
Ephedra sp.	6	R	50.0	5.6
Flourensia cernua	1	+	8.3	0.9
Fouquieria splendens	4	R	33.3	3.7
Koeberlinia spinosa	1	+	8.3	0.9
Larrea tridentata	9	1	75.0	8.3
Nolina sp.	3	1	25.0	2.8
Opuntia spp.	2	R	16.7	1.8
Parthenium incanum	12	2	100.0	11.1
Prosopis glandulosa	2	+	16.7	1.9
Rhus aromatica	1	+	8.3	0.9
Rhus microphylla	2	1	16.7	1.9
Viguiera stenoloba	5	1	41.7	4.6
Xanthocephalum Sarothrae	5	1	41.7	4.6

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Yucca elata	4	R	33.3	3.7
Yucca Torreyi	2	R	16.7	1.9
<u>Grasses</u>				
Aristida sp.	1	1	8.3	0.9
Bouteloua curtipendula	7	2	58.3	6.5
Bouteloua eriopoda	5	2	41.3	4.6
Bouteloua gracilis	1	1	8.3	0.9
Hilaria mutica	2	1	16.7	1.9
Lycurus phleoides	1	2	8.3	0.9
Muhlenbergia arenacea	1	R	8.3	0.9
Muhlenbergia Porteri	1	+	8.3	0.9
Muhlenbergia setifolia	1	1	8.3	0.9
Scleropogon brevifolius	1	1	8.3	0.9
Setaria macrostachya	1	+	8.3	0.9
Sporobolus cryptandrus	1	+	8.3	0.9
Sporobolus Wrightii	1	+	8.3	0.9
Tridens muticus	1	R	8.3	0.9
Grass spp.	3	2	25.0	2.8

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Larrea tridentata

MAP SYMBOL: 20

QUADRANTS: 2 32 71 77 112 117 136 139 141 212
6 62 72 111 114 118 138 140 209 279
20 63

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	1	+	4.5	1.2
Artemisia filifolia	1	+	4.5	1.2
Atriplex canescens	1	R	4.5	1.2
Berberis trifoliolata	2	+	9.1	2.5
Dalea formosa	6	1	27.3	7.5
Ephedra sp.	1	R	4.5	1.2
Flourensia cernua	4	+	18.2	5.0
Larrea tridentata	22	2	100.0	27.5
Opuntia spp.	5	R	22.7	6.2
Parthenium incanum	3	+	13.6	3.8
Prosopis glandulosa	6	+	27.3	7.5
Rhus microphylla	1	R	4.5	1.2
Xanthocephalum Sarothrae	12	1	54.5	15.0
Yucca baccata	1	+	4.5	1.2
Yucca elata	2	R	9.1	2.5
Grasses				
Aristida sp.	1	R	4.5	1.2
Grass spp.	11	+	50.0	13.8

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Larrea tridentata - Grass

MAP SYMBOL: 21

QUADRANTS: 12 43 70 131 142 149 150 151 160 267
17 44 99 137 143

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Dalea formosa	1	1	6.7	1.5
Dyssodia acerosa	1	1	6.7	1.5
Flourensia cernua	2	+	13.3	3.0
Larrea tridentata	15	2	100.0	22.4
Opuntia spp.	5	R	33.3	7.5
Parthenium incanum	3	+	20.0	4.5
Prosopis glandulosa	2	+	13.3	3.0
Xanthocephalum Sarothrae	10	1	66.7	14.9
Yucca baccata	1	1	6.7	1.5
Yucca elata	2	1	13.3	3.0
Grasses				
Hilaria mutica	1	2	6.7	1.5
Muhlenbergia arenacea	3	1	20.0	4.5
Muhlenbergia Porteri	2	2	13.3	3.0
Scleropogon brevifolius	1	1	6.7	1.5
Setaria macrostachya	1	1	6.7	1.5
Sporobolus Wrightii	8	1	53.3	11.9
Tridens muticus	7	1	46.7	10.4
Grass spp.	2	2	13.3	3.0

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Larrea tridentata - Parthenium incanum - Grass

MAP SYMBOL: 22

QUADRANTS: 19 115 129 166 175 186 196 197 220 298
25 125 145 167 176

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	3	1	20.0	3.0
Aloysia Wrightii	1	+	6.7	1.0
Dalea formosa	5	R	33.3	5.0
Dyssodia acerosa	1	R	6.7	1.0
Ephedra sp.	1	+	6.7	1.0
Eurotia lanata	1	1	6.7	1.0
Flourensia cernua	3	1	20.0	3.0
Fouquieria splendens	2	R	13.3	2.0
Koeberlinia spinosa	1	+	6.7	1.0
Larrea tridentata	15	2	100.0	15.2
Opuntia spp.	4	R	26.7	4.0
Parthenium incanum	15	1	100.0	15.2
Prosopis glandulosa	6	+	40.0	6.1
Rhus microphylla	3	+	20.0	3.0
Viguiera stenoloba	1	1	6.7	1.0
Xanthocephalum Sarothrae	11	1	73.3	11.1
Yucca baccata	1	+	6.7	1.0
Yucca elata	3	1	20.0	3.0
Yucca Torreyi	2	R	13.3	2.0
Grasses				
Aristida sp.	1	R	6.7	1.0
Bouteloua curtipendula	1	1	6.7	1.0

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Bouteloua eriopoda	1	1	6.7	1.0
Muhlenbergia Porteri	2	1	13.3	2.0
Setaria macrostachya	1	+	6.7	1.0
Sporobolus cryptandrus	2	1	13.3	2.0
Sporobolus Wrightii	1	1	6.7	1.0
Trichachne californica	1	1	6.7	1.0
Tridens muticus	9	2	60.0	9.1
Grass spp.	1	2	6.7	1.0

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Larrea tridentata - Prosopis glandulosa - Xanthocephalum Sarothrae

MAP SYMBOL: 23

QUADRANTS:									
1	39	42	82	128	135	159	163	169	218
3	41	58	122	130	147	161	168	170	219
18									

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Atriplex canescens	3	R	14.2	2.9
Dalea formosa	2	R	9.5	2.0
Dyssodia acerosa	1	+	4.8	1.0
Ephedra sp.	1	R	4.8	1.0
Eurotia lanata	1	+	4.8	1.0
Flourensia cernua	5	1	23.4	4.9
Larrea tridentata	21	2	100.0	20.6
Opuntia spp.	4	R	19.0	4.0
Parthenium incanum	4	1	19.0	4.0
Prosopis glandulosa	21	2	100.0	20.6
Rhus microphylla	2	1	9.5	2.0
Xanthocephalum Sarothrae	15	1	71.4	14.7
Yucca baccata	1	R	4.8	1.0
Yucca elata	5	1	23.8	4.9
Yucca Torreyi	1	1	4.8	1.0
Grasses				
Hilaria mutica	1	1	4.8	1.0
Muhlenbergia Porteri	4	2	19.0	4.0
Sporobolus cryptandrus	4	2	19.0	4.0
Tridens muticus	2	1	9.5	2.0
Grass spp.	4	2	19.0	4.0

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Larrea tridentata - Flourensia cernua - Grass

MAP SYMBOL: 25

QUADRANTS: 33 48 76 95 146 153 188 272 273 294
35 73 88 123 148 182

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	1	+	6.2	1.1
Artemisia filifolia	1	2	6.2	1.1
Atriplex canescens	3	+	18.8	3.3
Dyssodia acerosa	1	R	6.2	1.1
Ephedra sp.	1	+	6.2	1.1
Flourensia cernua	16	2	100.0	17.8
Fouquieria splendens	2	R	12.5	2.2
Koeberlinia spinosa	1	+	6.2	1.1
Larrea tridentata	16	2	100.0	17.8
Nolina sp.	1	2	6.2	1.1
Opuntia spp.	3	+	18.8	3.3
Parthenium incanum	4	1	25.0	4.4
Prosopis glandulosa	7	1	43.8	7.8
Xanthocephalum Sarothrae	7	1	43.8	7.8
Yucca elata	2	1	12.5	2.2
Yucca Torreyi	1	R	6.2	1.1
Grasses				
Hilaria mutica	4	2	25.0	4.4
Muhlenbergia arenacea	3	2	18.8	3.3
Muhlenbergia Porteri	6	2	37.5	6.7
Muhlenbergia setifolia	1	1	6.2	1.1
Panicum obtusum	1	2	6.2	1.1

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Scleropogon brevifolius	4	2	25.0	4.4
Sporobolus cryptandrus	1	R	6.2	1.1
Tridens muticus	1	1	6.2	1.1
Grass spp.	2	2	12.5	2.2

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Acacia constricta - Grass

MAP SYMBOL: 30

QUADRANTS: 45 90 94 180 222 237 255 256 257 268
46 93 97 199

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	14	2	100.0	14.4
Atriplex canescens	1	+	7.1	1.0
Berberis trifoliolata	3	+	21.4	3.1
Dalea formosa	6	1	42.9	6.2
Dalea scoparia	1	R	7.1	1.0
Dyssodia acerosa	3	+	21.4	3.1
Ephedra sp.	6	R	42.9	6.2
Flourensia cernua	4	R	28.6	4.1
Fouquieria splendens	1	R	7.1	1.0
Koeberlinia spinosa	2	+	14.3	2.1
Krameria glandulosa	1	+	7.1	1.0
Larrea tridentata	4	+	28.6	4.1
Opuntia spp.	4	R	28.6	4.1
Parthenium incanum	10	1	71.4	10.3
Prosopis glandulosa	2	R	14.3	2.1
Xanthocephalum Sarothrae	7	1	50.0	7.2
Yucca baccata	1	+	7.1	1.0
Yucca elata	3	R	21.4	3.1
Grasses				
Bouteloua curtipendula	6	2	42.9	6.2
Bouteloua eriopoda	2	2	14.3	2.1
Bouteloua hirsuta	1	1	7.1	1.1

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Hilaria mutica	6	2	42.9	6.2
Scleropogon brevifolius	3	1	21.4	3.1
Tridens muticus	3	R	21.4	3.1
Grass spp.	3	+	21.4	3.1

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Acacia constricta - Larrea tridentata - Grass

MAP SYMBOL: 31

QUADRANTS: 4 5 21 164 165 177 193 194 283 298

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	10	2	100.0	13.5
Berberis trifoliolata	1	R	10.0	1.4
Dyssodia acerosa	4	1	40.0	5.4
Ephedra sp.	4	R	40.0	5.4
Flourensia cernua	6	1	60.0	8.1
Fouquieria splendens	2	R	20.0	2.7
Koeberlinia spinosa	1	+	10.0	1.4
Larrea tridentata	10	1	100.0	13.5
Opuntia spp.	6	R	60.0	8.1
Parthenium incanum	4	R	40.0	5.4
Prosopis glandulosa	2	R	20.0	2.7
Rhus microphylla	2	1	20.0	2.7
Viguiera stenoloba	1	R	10.0	1.4
Xanthocephalum Sarothrae	5	R	50.0	6.8
Yucca baccata	2	1	20.0	2.7
Yucca Torreyi	1	R	10.0	1.4
Grasses				
Aristida sp.	1	1	10.0	1.4
Bouteloua eriopoda	2	2	20.0	2.7
Hilaria mutica	2	1	20.0	2.7
Muhlenbergia arenacea	1	1	10.0	1.4
Scleropogon brevifolius	1	1	10.0	1.4

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Sporobolus cryptandrus	1	1	10.0	1.4
Sporobolus Wrightii	1	2	10.0	1.4
Tridens muticus	3	1	30.0	4.1
Grass spp.	1	2	10.0	1.4

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Flourensia cernua - Grass

MAP SYMBOL: 40

QUADRANTS: 16 50 75 100 154 184 205 269 284 302
34

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	1	+	9.1	1.5
Atriplex canescens	6	1	54.5	9.1
Berberis trifoliolata	1	+	9.1	1.5
Flourensia cernua	11	2	100.0	16.7
Larrea tridentata	4	R	36.4	6.1
Opuntia spp.	5	R	45.4	7.6
Prosopis glandulosa	6	R	54.5	9.1
Rhus microphylla	1	R	9.1	1.5
Xanthocephalum Sarothrae	1	1	9.1	1.5
Yucca elata	3	R	27.3	4.5
Grasses				
Bouteloua eriopoda	1	1	9.1	1.5
Bouteloua gracilis	2	1	18.2	3.0
Hilaria mutica	8	3	72.7	12.1
Muhlenbergia arenacea	2	R	18.2	3.0
Panicum obtusum	1	R	9.1	1.5
Scleropogon brevifolius	6	3	54.5	9.1
Setaria macrostachya	3	R	27.3	4.5
Sporobolus contractus	1	4	9.1	1.5
Sporobolus Wrightii	2	2	18.2	3.0
Grass spp.	1	2	9.1	1.5

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Flourensia cernua - Larrea tridentata - Grass

MAP SYMBOL: 41

QUADRANTS: 7 152 162 185 192 303

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	2	1	33.3	5.6
Atriplex canescens	3	+	50.0	8.3
Ephedra sp.	1	+	25.0	2.8
Flourensia cernua	6	2	100.0	16.7
Larrea tridentata	6	1	100.0	16.7
Prosopis glandulosa	3	1	50.0	8.3
Viguiera stenoloba	1	1	16.7	2.8
Xanthocephalum Sarothrae	2	+	33.3	5.6
Yucca elata	3	1	50.0	8.3
Yucca Torreyi	1	+	16.7	2.8
Grasses				
Hilaria mutica	1	4	16.7	2.8
Muhlenbergia arenacea	1	2	16.7	2.8
Muhlenbergia Porteri	2	2	33.3	5.6
Sporobolus giganteus	1	+	16.7	2.8
Grass spp.	3	2	50.0	8.3

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Prosopis glandulosa - Xanthocephalum Sarothrae - Atriplex canescens - Grass

MAP SYMBOL: 50

QUADRANTS:

8	24	54	66	80	103	116	156	210	278
9	51	56	67	81	104	121	157	211	280
14	52	59	68	83	105	133	171	275	299
23	53	60	69	102	113	155	172		

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	2	R	5.4	1.2
Atriplex canescens	27	1	73.0	16.8
Berberis trifoliolata	2	+	5.4	1.2
Dalea formosa	1	1	2.7	0.6
Ephedra sp.	11	R	30.0	6.8
Flourensia cernua	2	R	5.4	1.2
Larrea tridentata	3	+	8.1	1.9
Opuntia spp.	1	+	2.7	0.6
Parthenium incanum	2	R	5.4	1.2
Prosopis glandulosa	37	2	100.0	23.0
Xanthocephalum Sarothrae	35	1	94.6	21.7
Yucca baccata	3	+	8.1	1.9
Yucca elata	19	+	51.4	11.8
Yucca Torreyi	2	R	5.4	1.2
Grasses				
Aristida sp.	1	+	2.7	0.6
Setaria macrostachya	1	R	2.7	0.6
Sporobolus contractus	2	1	5.4	1.2
Sporobolus cryptandrus	9	2	24.3	5.6
Tridens muticus	1	1	2.7	0.6

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Prosopis glandulosa - Larrea tridentata

MAP SYMBOL: 51

QUADRANTS: 40 134 144

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Atriplex canescens	2	R	66.7	13.3
Larrea tridentata	3	1	100.0	20.0
Parthenium incanum	1	1	33.3	6.7
Prosopis glandulosa	3	2	100.0	20.0
Xanthocephalum Sarothrae	3	2	100.0	20.0
Yucca elata	1	+	33.3	6.7
Grasses				
Grass spp.	2	1	66.7	13.3

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Prosopis glandulosa - Artemisia filifolia

MAP SYMBOL: 52

QUADRANTS: 106 108 109 119

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	4	1	100.0	16.0
Atriplex canescens	4	+	100.0	16.0
Ephedra sp.	2	R	50.0	8.0
Prosopis glandulosa	4	2	100.0	16.0
Xanthocephalum Sarothrae	4	1	100.0	16.0
Yucca elata	4	+	100.0	16.0
Grasses				
Grass spp.	3	+	75.0	12.0

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Artemisia filifolia - Grass

MAP SYMBOL: 60

QUADRANTS: 26 28 31 120 216 244 246 247 270 292
27 30 37 214 243 245

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Trees				
Juniperus monosperma	1	+	6.2	1.1
Quercus undulata	1	+	6.2	1.1
Shrubs				
Artemisia filifolia	16	2	100.0	18.4
Atriplex canescens	4	R	25.0	4.6
Dalea scoparia	2	2	12.5	2.3
Ephedra sp.	9	R	56.2	10.3
Larrea tridentata	1	R	6.2	1.1
Opuntia spp.	1	R	6.2	1.1
Prosopis glandulosa	2	R	12.5	2.3
Rhus microphylla	1	+	6.2	1.1
Thelesperma longipes	3	R	18.8	3.4
Xanthocephalum Sarothrae	9	1	56.2	10.3
Yucca elata	13	R	81.3	14.9
Grasses				
Aristida sp.	1	R	6.2	1.1
Bouteloua eriopoda	1	2	6.2	1.1
Bouteloua hirsuta	1	2	6.2	1.1
Muhlenbergia setifolia	1	3	6.2	1.1
Sporobolus contractus	4	1	25.0	4.6
Sporobolus cryptandrus	14	2	87.5	16.1
Sporobolus flexuosus	1	R	6.2	1.1
Tridens muticus	1	2	6.2	1.1

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Artemisia filifolia - Prosopsis glandulosa

MAP SYMBOL: 61

QUADRANTS: 36 242

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Artemisia filifolia	2	2	100.0	18.2
Ephec' sp.	1	+	50.0	9.1
Prosopis glandulosa	2	1	100.0	18.2
Xanthocephalum Sarothrae	2	1	100.0	18.2
Yucca elata	2	R	100.0	18.2
Grasses				
Sporobolus cryptandrus	1	2	50.0	9.1
Grass spp.	1	1	50.0	9.1

APPENDIX F. (Continued)

Summary of Phytosociological Data by Plant Community.

PLANT COMMUNITY: Other

MAP SYMBOL: 90

QUADRANTS: 13 61 190 248

SPECIES	NO. OF QUADRANTS	COVER CLASS	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY
Shrubs				
Acacia constricta	2	+	50.0	7.7
Atriplex canescens	2	R	50.0	7.7
Berberis trifoliolata	1	+	25.0	3.8
Dyssodia acerosa	1	R	25.0	3.8
Ephedra sp.	3	+	75.0	11.5
Flourensia cernua	1	+	25.0	3.8
Larrea tridentata	4	R	100.0	15.4
Opuntia spp.	1	+	25.0	3.8
Parthenium incanum	1	R	25.0	3.8
Prosopis glandulosa	2	1	50.0	7.7
Viguiera stenoloba	2	R	50.0	7.7
Xanthocephalum Sarothrae	1	R	25.0	3.8
Yucca Torreyi	1	+	25.0	3.8
Grasses				
Muhlenbergia arenacea	1	R	25.0	3.8
Tridens muticus	1	1	25.0	3.8
Grass spp.	2	R	50.0	7.7

APPENDIX G

A Listing of the Flora of the Fort Bliss and Adjacent Areas in South-Central New Mexico Plant Community.

<u>POLYPODIACEAE</u> (True Ferns)
Cheilanthes Wrightii Hook (Wright lipfern)
<u>PINACEAE</u> (Pine Family)
Juniperus monosperma (Engelm.) Sarg. (oneseeded juniper; cedar)
Pinus edulis Engelm. (pinyon pine)
<u>EPHEDRACEAE</u> (Ephedra Family)
Ephedra aspera Engelm. (popotillo; Mormon tea)
Ephedra trifurca Torr. (long-leaf ephedra; Mormon tea)
<u>GRAMINEAE</u> (Grasses)
Andropogon barbinodis, Lag.
Andropogon saccharoides, Swartz (Silver beardgrass)
Aristida adscensionis, L. (Six weeks three-awn)
Aristida arizonica, Vasey (Arizona three-awn)
Aristida divaricata, Humb. and Bonpl. ex Willd (Poverty three-awn)
Aristida longiseta, Steud. (Red three-awn)
Aristida pansa, Wort. and Standl. (Wooten three-awn)
Aristida parishii, Hitchc.
Aristida purpurascens, Poir. (Arrow feather)
Bouteloua barbata, Lag. (Six weeks grama)
Bouteloua breviseta, Vasey.
Bouteloua curtipendula (Michx) Torr. (Side oats grama)
Bouteloua eriopoda, (Torr.) Torr. (Black grama)
Bouteloua gracilis, (H.B.K.) Lag. ex Steud. (Blue grama)
Bouteloua hirsuta, Lag. (Hairy grama)
Bouteloua uniflora, Vasey.
Cenchrus pauciflorus, Benth. (Field sandbur)
Chloris virgata, Swartz. (Feather fingergrass)
Echinochloa crusgalli var. *Mitis*, (Pursh.) Peterm. (Barnyard grass)
Enneapogon desvauxii, Beauv. (Spiked pappusgrass)
Eragrostis intermedia, Hitchc. (Plains lovegrass)
Hilaria belangeri, (Steud.) Nash. (Curly Mesquite)
Hilaria mutica, (Buckl.) Benth. (Tobosa grass)
Leptochloa dubia, (H.B.K.) Nees. (Green sprangletop)
Lycurus phleoides, H.B.K. (Wolftail)
Muhlenbergia arenacea, (Buckl.) Hitchc.
Muhlenbergia arenicola, Buckl.
Muhlenbergia emersleyi, Vasey (Bullgrass)
Muhlenbergia pauciflora, (Buckl.) (New Mexican muhly)
Muhlenbergia Porteri, Scribn. (Bush muhly)
Muhlenbergia pungens, Thurb.
Muhlenbergia revenchoni, Vasey and Scribn.
Muhlenbergia rigida, (H.B.K.) Kunth. (Purple muhly)
Muhlenbergia setifolia, Vasey

APPENDIX G. (Continued)

A Listing of the Flora of the Fort Bliss and Adjacent Areas in South-Central New Mexico Plant Community.

GRAMINEAE (Cont'd)
- *Muhlenbergia Torreyi*, (Kunth.) Hitchc. ex Bush. (Ring grass)
- *Muhlenbergia xerophila*, C.O. Goodding
- *Panicum obtusum*, H.B.K. (Vine-mesquite)
- *Panicum pampinosum*, Hitchc. and Chase
- *Scleropogon brevifolius*, Phil. (Burro grass)
- *Setaria macrostachya*, H.B.K. (Plains bristlegrass)
- *Sporobolus asper*, (Michx.) Kunth.
- *Sporobolus contractus*, Hitchc. (Spike dropseed)
- *Sporobolus cryptandrus*, (Torr.) A. Gray. (Sand dropseed)
- *Sporobolus flexuosus*, (Thurb.) Rydb. (Mesa dropseed)
- *Sporobolus giganteus*, Nash. (Giant dropseed)
- *Sporobolus Wrightii*, Munro ex Scribn. (Sacaton)
- *Stipa Pringlei*, Scribn. (Pringle needlegrass)
- *Trichachne californica*, (Benth.) Chase. (Cottontop)
- *Trichachne Hitchcockii*, (Chase) Chase
- *Tridens elongatus*, (Buckl.) Nash (Rough tridens)
- *Tridens muticus*, (Torr.) Nash (Slim tridens)
- *Tridens pulchellus*, (H.B.K.) Hitchc.

LILIACEAE (Lily Family)
- *Dasylirion Wheeleri* Wats. (Wheeler sotol)
- *Nolina spp.*, Michx.
- *Yucca baccata*, (Engelm.) Trel. (datil; banana yucca)
- *Yucca elata*, Engelm. (soaptree yucca)
- *Yucca Torreyi*, Shafer (Spanish dagger; Torrey yucca)

AMARYLLIDACEAE (Amaryllis Family)
- *Agave lecheguilla*, Torr. (lecheguilla)
- *Agave Parryi*, Engelm. (mescal; Parry agave)

SALICACEAE (Willow Family)
- *Populus* sp. L. (cottonwood; poplar)
- *Salix gooddingii* Ball (Southwestern black willow)

FAGACEAE (Beech Family)
- *Quercus undulata* (wavy leaf oak)

ULMACEAE (Elm Family)
- *Celtis reticulata* Torr. (netleaf hackberry)
- *Ulmus* sp. L. (elm)

CHENOPODIACEAE (Goosefoot Family)
- *Atriplex canescens* (Pursh.) Nutt. (fourwing saltbush)
- *Eurotia lanata* (Pursh.) Moq. (common winterfat)
- *Salsola kali* L. (Russian thistle)

BRASSICACEAE (Mustard Family)
- *Dithyrea Wislizenii* Engelm. var. *Wislizenii*
- *Lepidium lasiocarpum* Nutt. var. *Wrightii* (Gray) Hitchc. (hairypod spectaclepod)
- *Lepidium montanum* var. *alyssoides* (Gray) Jones (mountain pepperweed)
- *Lepidium montanum* var. *angustifolium* Hitchc. (fleshy pepperweed)

ROSACEAE (Rose Family)
- *Cercocarpus montanus* Raf. var. *paucidentatus* (Wats.) F.L. Martin (shaggy mountain mahogany)
- *Fallugia paradoxa* (Don.) Endl. (Apache plume)

APPENDIX G. (Continued)

A Listing of the Flora of the Fort Bliss and Adjacent Areas in South-Central New Mexico Plant Community.

<u>LEGUMINOSAE</u> (Legumes)
Acacia constricta Benth. ex Gray (mescat acacia; whitethorn)
Caesalpinia Jamesii (T. & G.) Fisher (bird-of-paradise)
Cassia Lindheimeriana Scheele (Lindheimer senna)
Dalea formosa Torr. (feather dalea)
Dalea lanata Spreng. (wooly dalea)
Dalea scoparia Gray (broom dalea)
Hoffmanseggia glauca (Ort) Eifert (rush pea)
Parkinsonia aceleata L. Retama)
Prosopis glandulosa Torr. var. *Torreyana* (Benson) M.C.Johnst. (western honey mesquite)
<u>KRAMERIACEAE</u> (Ratany Family)
Krameria ramosissima Wats. (calderona)
Krameria glandulosa Rose & Painter (range ratany)
<u>ZYGOPHYLLACEAE</u> (Caltrop Family)
Larrea tridentata (DC.) Cav. (creosotebush; greasewood)
<u>ANACARDIACEAE</u> (Sumac Family)
Rhus aromatica Ait. var. *pilosissima* (Engl.) Shinners (skunkbush; fragrant sumac)
Rhus microphylla Gray (littleleaf sumac)
<u>RHAMNACEAE</u> (Buckthorn Family)
Ceanothus Greggi Gray (desert ceanothus)
Condalia ericoides (Gray) M.C.Johnst. (javelina bush)
Condalia mexicana, Schlecht
Condalia spathulata Gray (knifelead condalia)
<u>MALVACEAE</u> (Mallow Family)
Hibiscus denudatus Benth. (paleface rosemallow)
Sphaeralcea sp.
<u>FOUQUIERIACEAE</u> (Ocotillo Family)
Fouquieria splendens Engelm. (ocotillo)
<u>KOEBERLINIACEAE</u> (Allthorn Family)
Koeberlinia spinosa Zucc. (allthorn)
<u>CACTACEAE</u> (Cacti)
Opuntia Engelmanii (Engelman Prickly pear)
Opuntia imbricata (Haw.) DC. var. *imbricata* (cane cholla; tree cholla)
Opuntia leptocaulis DC. var. *leptocaulis* (pencil cholla; Christmas cactus)
Opuntia spp.
<u>TAMARICACEAE</u> (Tamarisk Family)
Tamarisk ramosissima Ledeb (salt cedar)
<u>CONVOLVULACEAE</u> (Morning Glory Family)
Ipomoea sp. (morning glory)
<u>VERBENACEAE</u> (Verbain Family)
Aloysia Wrightii (Gray) Heller (Wright aloysia)
<u>SOLANACEAE</u> (Nightshade Family)
Nicotiana trigonophylla Dunal (desert tobacco)
Solanum elaeagnifolium Cav. (silverleaf nightshade)
<u>SCROPHULARIACEAE</u> (Figwort Family)
Castilleja sp. L.f. (Indian paintbrush)
<u>BIGNONIACEAE</u> (Catalpa Family)
Chilopsis linearis (Cav.) DC. var. *linearis* (desert willow)

APPENDIX G. (Continued)

A Listing of the Flora of the Fort Bliss and Adjacent Areas in South-Central New Mexico Plant Community.

<u>CUCURBITACEAE</u> (Gourd Family)
  Cucurbita foetidissima H.B.K. (buffalogourd)
<u>ASTERACEAE</u> (Sunflower Family)
  Artemisia filifolia Torr. (sand sage)
  Baccharis glutinosa (R. &. P.) Pers. (seepwillow baccharis)
  Baileya multiradiata Harv. & Gray (desert baileya)
  Chrysothamnus nauseosus (Pall.) Britton (rubber rabbitbrush)
  Dyssodia acerosa DC. (prickleaf dogweed)
  Flourensia cernua DC. (tarbush; blackbrush)
  Gaillardia pinnatifida Torr. (slender gaillardia)
  Parthenium incanum H.B.K. (mariola parthenium)
  Psilostrophe tagetina Greene (wooly paperflower)
  Thelesperma longipes Gray (longstalk greenthread)
  Viguiera stenoloba Balke (skeleton goldeneye)
  Xanthocephalum microcephalum (DC.) Shinners (threadleaf snakeweed)
  Xanthocephalum Sarothrae (Pursh) Shinners (broom snakeweed)

APPENDIX H

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 10

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (O/O)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
200	A1	ALLU	1	1	Y	PAN	28
250	A1	BEDL	1	1	Y	GRA	28
288	A1	ALLU	0	0	N		65
198	A2	BEDL	0	0	Y	PAN	23
223	A2	SHAL	15	40	N		15
239	A2	ALLU	5	115	Y	PAN	45
249	A2	BEDL	0	1	Y	PAN	23
262	A2	BEDL	0	0	N		-08
263	A2	IGNE	0	0	N		-15
289	A2	BEDL	25	0	N		10
291	A2	BEDL	0	0	N		15
296	A2	BEDL	0	0	N		-15
297	A2	BEDL	15	0	N		+45
261	A3	IGNE	0	0	N		-15
92	B1	ALLU	0	250	Y	PAN	30
110	B1	IGNE	0	170	N		5
189	B1	ALLU	10	340	Y	PAN	35
206	B1	ALLU	2	240	Y	PAN	25
208	B1	ALLU	5	85	N		47
238	B1	ALLU	1	1	N		45
290	B1	ALLU	1	0	N		+45
47	B4	ALLU	2	225	Y	PAN	+30
271	B4	ALLU	0	0	N		100
281	B4	ALLU	0	0	N		+15
11	C1	EOLI	1	180	N		+75
55	C1	ALLU	5	90	N		+12
57	C1	EOLI	1	315	N		+30
74	C1	EOLI	6	90	N		+60
84	C1	EOLI	0	290	Y	PRE	46
158	C1	EOLI	1	270	Y	PAN	45
295	C1	EOLI	0	0	N		+45
64	C4	EOLI	3	90	Y	GRA	45
65	C4	EOLI	1	90	Y	PAN	45
78	C4	ALLU	1	1	Y	PAN	60
79	C4	ALLU	1	270	Y	PAN	60
107	C4	EOLI	0	25	N		80
132	C4	ALLU	2	350	Y	GRA	+60
173	C4	EOLI	0	40	Y	PRE	65
174	C4	EOLI	1	45	Y	PAN	45
213	C4	EOLI	1	60	N		63
217	C4	EOLI	0	0	N		60
265	C4	ALLU	0	0	N		+15
266	C4	ALLU	0	0	N		+15
277	C4	ALLU	0	0	N		+30
87	D	ALLU	1	0	Y	GRA	30
179	D	ALLU	3	240	N		30
240	D	ALLU	1	1	N		15
285	D	ALLU	0	0	N		30
304	D	BEDL	0	0	N		-15

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 11

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
201	A1	ALLU	1	1	Y	PAN	38
202	A1	ALLU	4	210	N		40
251	A1	BEDL	2	1	Y	GRA	40
286	A1	ALLU	0	0	N		+30
287	A1	BEDL	0	0	N		-30
86	A2	BEDL	0	0	N		10
236	A2	ALLU	4	210	Y	GRA	43
252	A2	BEDL	3	15	Y	PRE	30
91	B1	ALLU	4	250	Y	GRA	30
98	B1	ALLU	3	210	Y	PRE	13
191	B1	ALLU	3	290	N		30

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 12

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
183	B1	ALLU	0	50	N		45
15	B4	ALLU	0	0	N		+30
96	B4	ALLU	0	290	Y	PAN	+30
101	B4	ALLU	1	180	N		30
22	C1	ALLU	3	270	Y	PAN	+30
85	D	ALLU	0	60	N		15
221	D	ALLU	1	290	N		16

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 13

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
89	A1	BEDL	3	280	N		0
187	A2	SHAL	18	305	Y	PRE	15
195	A2	BEDL	2	80	N		15
204	B1	ALLU	4	200	Y	PAN	28

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 14

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
38	B5	ALLU	2	270	N		+15
10	C1	EOLI	4	273	N		+75
276	C1	EOLI	0	0	N		+60
29	C2	EOLI	3	180	N		+30
241	C2	EOLI	1	155	N		75
215	C4	EOLI	1	180	Y	GRA	53

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 15

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
203	A1	BEDL	12	210	N		10
207	B1	ALLU	1	10	N		41
259	C1	EOLI	0	0	N		+30
274	C2	EOLI	0	0	N		+30
293	C2	EOLI	0	0	Y	PAN	+75

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 15

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
49	A2	BEDL	26	270	N		-1
124	A2		0	0			
126	A2		0	0			
127	A2		0	0			
178	A2	BEDL	12	55	Y	PRE	10
181	A2	ALLU	8	180	Y	PRE	40
253	A2	BEDL	21	10	Y	PAN	20
254	A2	BEDL	0	0	N		30
260	A2	BEDL	0	0	N		-15
264	A2	BEDL	0	0	N		-30
282	A2	SHAL	0	0	Y	PRE	30
258	A3	EOLI	25	0	N		30

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 20

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
20	B1	ALLU	2	225	Y	PAN	30
71	B1	ALLU	5	240	N		18
111	B1	ALLU	2	300	Y	PAN	15
112	B1	ALLU	0	0	Y	PAN	15
114	B1	ALLU	3	205	Y	PRE	+30
117	B1	BEDL	4	45	Y	PAN	2
118	B1	ALLU	13	320	Y	PAN	15
140	B1	ALLU	5	270	Y	PAN	30
141	B1	ALLU	3	320	Y	PAN	30
209	B1	BEDL	10	230	N		30
212	B1	ALLU	3	40	N		25
2	B3	ALLU	1	55	Y	PAN	+15
72	B3	ALLU	2	330	Y	GRA	15
77	B3	ALLU	2	340	N		15
136	B3	ALLU	2	300	Y	GRA	+30
138	B3	ALLU	2	300	N		+30
139	B3	ALLU	2	300	N		+30
6	B4	ALLU	1	30	N		+30
62	C1	EOLI	1	90	Y	GRA	-15
63	C1	EOLI	1	270	Y	GRA	15
279	C1	EOLI	0	0	N		+15
32	C4	ALLU	0	0	Y	GRA	30

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 21

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
70	B1	ALLU	5	225	Y	GRA	18
99	B1	ALLU	3	210	Y	PRE	46
142	B1	ALLU	1	25	Y	PAN	35
143	B1	ALLU	1	50	Y	PAN	35
17	B3	ALLU	1	270	N		+30
43	B3	ALLU	2	300	Y	PAN	18
137	B3	ALLU	2	300	N		+30
149	B3	ALLU	1	315	N		90
150	B3	ALLU	1	315	N		90
151	B3	ALLU	0	70	N		90
267	B3	ALLU	0	0	N		
44	B4	ALLU	1	225	Y	GRA	25
160	B4	ALLU	4	300	N		60
12	C2	EOLI	0	1	N		+30
131	C4	ALLU	0	330	Y	GRA	+60

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 22

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
25	A2	ALLU	11	240	N		-18
115	A2	BEDL	6	30	Y	PRE	8
129	A2	ALLU	0	0			
196	A2	ALLU	2	1	Y	GRA	30
197	A2	ALLU	2	1	Y	GRA	30
220	A3	IGNE	33	340	N		2
19	B1	ALLU	2	180	Y	PAN	-15
125	B1	BEDL	0	0			
145	B1	ALLU	2	135	Y	GRA	23
186	B1	ALLU	3	275	Y	PAN	31
166	B3	BEDL	9	340	N		30
167	B3	ALLU	10	250	Y	GRA	15
175	B3	ALLU	4	30	Y	PAN	30
176	B3	ALLU	2	35	Y	PAN	30

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 23

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
128	A2	ALLU	0	0			
18	B1	ALLU	3	180	Y	PAN	-15
82	B1	ALLU	0	0	N		15
122	B1	BEDL	0	0			
147	B1	ALLU	2	20	Y	GRA	15
168	B1	ALLU	11	45	Y	GRA	30
218	B1	ALLU	3	280	N		45
219	B1	ALLU	3	280	N		45
1	B3	ALLU	2	60	N		+10
3	B3	ALLU	0	325	N		+15
41	B3	ALLU	1	180	Y	GRA	+15
42	B3	ALLU	1	225	Y	GRA	+15
73	B3	ALLU	0	330	N		30
160	B3	ALLU	10	135	N		+10
161	B4	ALLU	3	310	N		50
39	B5	ALLU	2	180	Y	GRA	+45
58	C1	EOLI	3	135	Y	PAN	30
135	C1	EOLI	4	180	N		30
159	C1	BEDL	12	240	Y	GRA	15
169	C1	ALLU	3	315	N		30
170	C1	ALLU	2	45	Y	GRA	45
130	C4	EOLI	0	10	Y	GRA	+63

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 25

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
182	A2	BEDL	35	240	N		-15
146	B1	ALLU	2	20	Y	GRA	15
146	B1	ALLU	1	70	Y	GRA	15
188	B1	ALLU	2	315	Y	GRA	60
272	B1	ALLU	0	0	N		+30
33	B3	ALLU	0	0	N		+30
76	B3	ALLU	2	300	N		+30
273	B3	ALLU	0	0	N		+15
35	B4	ALLU	2	225	N		+30
48	B4	ALLU	0	270	Y	PAN	30
95	B4	ALLU	1	290	Y	PAN	13
294	B4	ALLU	0	0	Y	PAN	35
123	B5	ALLU	0	0			
153	C2	EOLI	0	355	N		90
88	D	ALLU	0	0	N		+46

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 30

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
45	A2	BEDL	4	45	N		-15
46	A2	BEDL	4	1	N		-15
90	A2	ALLU	8	320	Y	PRE	15
93	A2	BEDL	6	130	Y	PAN	23
94	A2	BEDL	2	130	Y	PAN	15
97	A2	BEDL	9	225	Y	PAN	18
180	A2	ALLU	14	35	Y	PAN	33
199	A2	SHAL	11	195	N		25
222	A2	SHAL	27	130	N		15
237	A2	ALLU	19	215	Y	PAN	47
255	A2	ALLU	24	10	Y	PRE	15
256	A2	SHAL	20	215	N		35
257	A2	SHAL	16	125	Y	PRE	45
268	B1	BEDL	0	0	N		30

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 31

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
165	A2	ALLU	6	300	Y	PAN	17
193	A2	BEDL	12	315	Y	PAN	[illegible]
194	A2	BEDL	3	270	N		15
224	A2	SHAL	0	0	N		15
225	A2	SHAL	0	0	N		15
226	A2	SHAL	0	0	Y	PRE	35
227	A2	SHAL	0	0	N		15
228	A2	ALLU	0	0	N		15
229	A2	BEDL	[illegible]	0	N		30
230	A2	ALLU	0	0	N		45
231	A2	SHAL	0	0	N		15
232	A2	ALLU	0	0	N		15
233	A2	SHAL	0	0	N		15
234	A2	ALLU	0	0	N		15
235	A2	ALLU	0	0	N		47
283	A2	BEDL	0	0	Y	PAN	30
298	A2	BEDL	0	0	N		+15
4	B1	ALLU	2	37	N		+25
5	B1	ALLU	3	35	N		+25
21	B1	ALLU	4	225	Y	PAN	30
177	B1	ALLU	7	225	Y	PAN	38
164	D	ALLU	1	300	Y	PAN	30

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 40

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
154	A1	ALLU	1	270	N		45
184	B1	ALLU	0	90	N		45
16	B3	ALLU	0	0	N		+30
34	B3	ALLU	3	0	N		+30
75	B4	ALLU	1	270	N		30
100	B4	ALLU	1	180	Y	PAN	-15
269	B4	ALLU	0	0	N		+30
302	B4	ALLU	0	0	N		+30
56	D	ALLU	2	270	N		+30
205	D	ALLU	5	305	N		40
284	D	ALLU	1	0	N		30

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 41

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
192	B1	ALLU	1	290	N		30
152	B4	ALLU	0	1	N		90
162	B4	ALLU	1	290	Y	PAN	30
185	B4	ALLU	1	50	Y	PAN	30
303	B4	ALLU	0	1	N		90
7	D	ALLU	1	75	N		+30

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 50

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
299	A2	BEDL	12	240	Y	GRA	15
116	B1	ALLU	0	0	Y	PAN	30
69	B5	ALLU	0	0	N		30
113	B5	ALLU	4	185	N		+15
210	B5	ALLU	1	230	Y	GRA	45
211	B5	ALLU	1	230	Y	GRA	45
8	C1	EOLI	0	355	Y	GRA	+75
9	C1	EOLI	0	355	N		+75
23	C1	EOLI	3	270	Y	GRA	+30
24	C1	EOLI	3	270	Y	GRA	+30
51	C1	EOLI	2	180	Y	GRA	+30
52	C1	EOLI	2	180	Y	GRA	+30
53	C1	ALLU	1	180	N		+60
54	C1	EOLI	3	1	Y	GRA	+30
56	C1	EOLI	0	315	N		30
59	C1	EOLI	2	90	Y	GRA	45
60	C1	EOLI	2	1	Y	GRA	+45
66	C1	EOLI	1	90	N		+45
67	C1	ALLU	1	300	N		+40
68	C1	ALLU	2	135	N		+40
80	C1	ALLU	2	180	N		+30
81	C1	ALLU	2	180	Y	GRA	+30
83	C1	EOLI	0	300	Y	PAN	23
102	C1	EOLI	0	90	N		30
103	C1	EOLI	0	90	N		30
104	C1	EOLI	4	0	Y	PAN	33
105	C1	EOLI	4	0	Y	PAN	33
121	C1		0	0			
155	C1	EOLI	2	320	Y	GRA	40
156	C1	EOLI	1	50	Y	GRA	23
157	C1	EOLI	1	1	Y	PAN	45
171	C1	EOLI	1	45	Y	GRA	60
172	C1	EOLI	0	45	Y	PAN	60
278	C1	EOLI	0	0	N		+15
280	C1	EOLI	0	0	N		+15
14	C2	EOLI	0	0	Y	GRA	+45
133	C4	EOLI	0	1	Y	GRA	+30
275	C4	EOLI	0	0	Y	PRE	+30

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 51

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
144	B1	ALLU	3	225	Y	GRA	23
40	B5	ALLU	0	180	Y	GRA	+45
134	C1	EOLI	0	1	Y	GRA	+30

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 52

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
108	C1	EOLI	1	25	N		60
109	C1	EOLI	1	25	N		60
119	C1	EOLI	0	0			
106	C4	EOLI	0	280	Y	GRA	60

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 60

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	TYPE	SOIL DEPTH (CM)
270	A2	EOLI	0	0	N		+50
216	C1	EOLI	1	1	Y	GRA	52
28	C2	EOLI	2	180	N		+30
36	C2	EOLI	8	0	N		30
31	C2	EOLI	1	0	N		30
37	C2	ALLU	1	90	N		+15
120	C2	ALLU	0	0			
243	C2	EOLI	1	280	N		65
244	C2	EOLI	0	0	N		70
245	C2	EOLI	0	0	N		75
247	C2	EOLI	0	0	N		73
292	C2	EOLI	0	0	N		+60
26	C4	EOLI	1	90	Y	GRA	+15
27	C4	EOLI	1	1	Y	GRA	+30
214	C4	EOLI	0	0	Y	PAN	65
246	C4	EOLI	0	0	N		50

APPENDIX H. (Continued)

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 51

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
36	C2	ALLU	2	90	N		+15
242	C2	EOLI	1	0	N		75

SUMMARY OF TERRAIN DATA FOR SAMPLE SITES IN LAND COVER UNIT 90

SITE NUMBER	LANDFORM UNIT	PARENT MATERIAL	SLOPE (0/0)	SLOPE DIRECTION	CALICHE PRESENT	CALICHE TYPE	SOIL DEPTH (CM)
190	B1	ALLU	12	300	N		38
248	B1	ALLU	3	290	N		10
61	C1	EOLI	2	1	Y	GRA	+15
13	C2	ALLU	0	1	N		+15

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